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ART. I.—*On Terrestrial Magnetism;* by WILLIAM A. NORTON, Professor of Mathematics and Natural Philosophy in Delaware College.

I PROPOSE in the present article to show that, adopting certain fundamental conceptions with respect to the terrestrial magnetic forces, the magnetic may be deduced from the thermal elements of the earth. The first investigations tending to establish the existence of a physical connection between the heat and magnetism of the earth, seem to have been made by Sir David Brewster. In 1820 he announced the "discovery of two poles of maximum cold on opposite sides of the north pole of the earth," and in the vicinity of the two magnetic poles; and maintained the probability of some physical connection between the poles of maximum cold, and the magnetic poles. He also proved "that the circle of maximum heat, like the magnetic equator, did not coincide with the equinoctial line; that the isothermal lines and the lines of equal magnetic intensity, had the same general form surrounding and enclosing the magnetic poles and those of maximum cold; and that, by the same formula, *mutatis mutandis*, we could calculate the temperature and the magnetic intensity of any point of the globe." This subject has since been studied by several philosophers; and particularly by Captain Duperrey, and M. Kupffer of Kasan. The original memoirs of these authors I have not seen. The following is the substance of the account which Sir David Brewster gives of their investigations. In the years 1822–1825, Captain Duperrey made an extended system of magnetic observations in the vicinity of the equator, by which

he was enabled to trace the magnetic equator, with peculiar accuracy, through an extent of 247° of longitude. In his paper on the magnetic equator, subsequently published, he announced that he had discovered that "the points of this great circle, or those where the magnetic intensity is a minimum, are also the warmest points of each meridian," and thus that "the thermal and magnetic equator are connected, as Sir David Brewster had already proved to be the case with the thermal and magnetic poles;" also, "that in comparing the isothermal and isodynamic lines, he had found a remarkable analogy in their curvatures and particularly in the direction of their concavities, and convexities." M. Kupffer, in certain memoirs read before the Russian Academy about the year 1829, attempted to establish that terrestrial magnetism resides at the surface of the globe, and thence inferred the existence of a connection between the magnetic and thermal phenomena of the earth: conceiving that the intensity of the earth's magnetism would vary directly or inversely as the temperature, according as it was of the nature of permanent or induced magnetism.

Several conjectures have been formed as to the nature of the connection between the temperature and magnetism of the earth. Dr. Traill has expressed the opinion that "the disturbance of the equilibrium of the temperature of our planet, by the continual action of the sun's rays on its intertropical regions, and by the polar ices, must convert the earth into a vast thermo-magnetic apparatus." Christie has suggested that "difference of temperature may be the primary cause of the polarity of the earth, though its influences may be modified by other circumstances." Œrsted conceives that the sun, by producing evaporation, deoxydation, &c., as well as by increasing the temperature, is the exciting cause of electrical currents, which perpetually traversing the earth's surface in a direction nearly parallel to the equator, give to the earth "a constant magnetic polarity." Perhaps the more generally received theory of the present day concerning the physical nature of the earth's magnetism, is that it consists of thermo-electric currents circulating at or near the earth's surface, induced by the heat of the sun. Prof. Barlow, who adopts this view, conceives that only one link is wanting to complete the explanation of terrestrial magnetism, viz. the discovery of the metallic thermo-magnetic apparatus. Brewster remarks upon this, that "if it could be shown that the action of solar heat is capable of developing magnetism in particles such as those which are known to constitute our globe, the great difficulty would be removed."

In seeking for the explanation of the connection between the magnetic and thermal phenomena of the earth, philosophers seem hitherto to have regarded the heat as only modifying in some in-

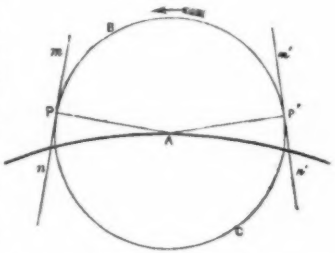
explicable manner the intensity of the magnetism of the terrestrial particles; or as bearing towards it the relation of cause and effect. But there is another view to be taken of the matter. We may regard the two principles of heat and magnetism as similar in their ultimate physical nature, as every where subsisting together, and that the causes which produce a variation of temperature at the surface of the earth, as we pass from one point to another, occasion at the same time and in like manner a variation of the magnetic intensity of the particles. So that the temperature at each particular place may be taken as the approximate measure of the molecular magnetic intensity there. The conception that I have formed of the probable physical nature of the imponderables, of which I have given an exposition in a paper read before the American Philosophical Society in December last, has led me to take this view of the physical relations subsisting between the heat and magnetism of the earth. This conception is, essentially, that all the phenomena of the imponderables are but different effects of different vibratory motions of the particles of matter, and of the ethereal undulations produced by these vibrations;—the vibrations answering to the different principles of light, heat and electricity, differing in time and intensity, and possibly in some instances in direction, of vibration. Agreeably to this general theory I conceive each particle of the earth's mass to be the centre of a system of undulatory movements propagated through the surrounding ether, and of every variety of time and intensity of vibration within certain limits. To the waves or pulses of feeblest intensity and shortest time of vibration I attribute the phenomena of magnetism; or, at all events, I suppose the waves of magnetism to lie at the opposite extreme from the waves of heat. It thus happens that all the particles of the magnetic needle receive the impulsive actions of the waves of magnetism propagated from the particles of matter at the earth's surface, and at certain depths below the surface;—from how great a depth will depend upon the degree of transparency, to these waves, of the matter of the earth. That the principle of magnetism is incoercible, or that it passes freely through opake bodies of ordinary thickness, has been fully established by the experiments of M. Haldat: and that all the particles of the magnetic needle are subject to the action of the magnetic force of the earth, is evident from the fact that the directive force of the needle is proportional to its mass. Why it is that magnets alone are sensibly influenced by the impulsive actions of the ethereal pulses, I cannot now stop to consider. These theoretical views, I do not here present for the purpose of advocating them, but simply because they furnish a simple and comprehensive conception of the terrestrial magnetic forces and of their relations to the earth's temperature. The mechanical theory of terrestrial magnetism which

it is the main design of the present article to exhibit, and apply, although suggested by these views, is not necessarily dependent upon them. The quantitative results arrived at, simply establish the existence of the forces supposed and of the relations conceived to subsist between them and the temperature of the earth. Different views may be entertained of the physical origin of these forces; or, we may rest upon the forces themselves as so many primary properties of matter.

The mechanical theory of the magnetism of the earth, of which I propose to give an exposition, is based upon the following fundamental principles. These were obtained inferentially from the physical theory of terrestrial magnetism which has been briefly explained: but for our present purpose, they may be regarded as mere assumptions, to be tested by the conclusions and results to which they lead.

1. Every particle of matter at the earth's surface, and to a certain depth below the surface, is the centre of a magnetic force exerted tangentially to the circumference of every vertical circle that may be conceived to be traced around it. Thus, if A, fig. 1, be a particle of the earth's mass at or near the surface, P a particle of a magnetic needle, and BPC a circle traced in a vertical plane around A as a centre and passing through P, P will be urged by a force whose line of direction is the tangent mPn. Whether there are probably tangential forces lying also in oblique planes, I do not here consider. If there are such forces it appears from the results of the investigation that they may be disregarded in the present inquiry. According to the views which have been offered of the probable physical nature of magnetism, the tangential forces here supposed are due to the transversal vibrations of the ethereal waves of magnetism propagated from the point A, and originated by certain vibratory movements of the particle at A.

Fig. 1.



2. The direction of this force will be different according as it solicits the north or south end of the needle; and it is always such, that to the north of the acting particle the north end of the needle is urged downwards and the south end upwards, and that to the south of the same particle the north end is urged upwards and the south end downward. Thus, in fig. 1, if P be to the north of A and P′ to the south of it, at P the north end of a magnetic needle will be solicited to move in the direction Pn, and the south end in the direction Pm; and at P′ the north end will be solicited in the direction P′m', and the south end in the

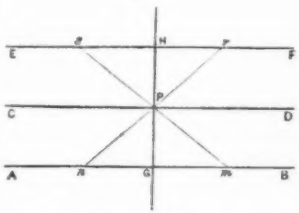
direction P′*n*′. This amounts to saying that the magnetic force of A in its action upon the north end of the needle is directed tangentially in the circle from right to left, as shown by the arrow, and in its action upon the south end of the needle is directed from left to right.

Upon the undulatory theory of magnetism these differences of action are attributable to ethereal waves whose transversal forces of vibration lie in opposite directions, and to certain differences in the magnetic states of the two ends of the needle.

3. The intensity of the magnetic force of a particle of the earth, at a given distance, is assumed to be approximately proportional to its temperature, or amount of sensible heat. This assumption was made under the idea that the sun was the source, at the same time of waves of heat, light and magnetism, and that the molecular forces of vibration due to the different kinds of waves would probably vary according to the same law in passing from one point to another on the earth's surface.

The magnetic force of a particle at the earth's surface, and for a certain depth below the surface, will have a certain mean intensity about which the actual intensity will vary during the day and year, by an amount decreasing with the depth. Beyond a certain depth, the magnetic intensity, like the temperature, will remain the same throughout the year, and will have a value greater than the surface mean in proportion as we descend lower. Lines conceived to be traced on the earth's surface connecting the points where the annual mean magnetic intensity of the particles near the surface is the same, will, according to the present view, coincide with the isogeothermal lines, and very nearly therefore with the isothermal lines. Let then, AB, CD, EF, fig. 2, represent portions of three isogeothermal lines, regarded as parallel to each other, and GPH an arc of a great circle crossing these lines perpendicularly. If we take four points *m*, *n*, *r*, *s*, similarly situated with respect to GPH, the action of the particle *m* upon the north end of a magnetic needle will be perpendicular to *m*P and directed obliquely downward. The action of the particle *n* will be perpendicular to *n*P and also directed obliquely downward. The magnetic forces of the particles *r*, *s*, will be respectively perpendicular to *r*P and *s*P and directed obliquely upward. Now it is evident that while one effect of the action of *m* will be to urge the north end of the needle toward C, the particle *n* will have an equal tendency to urge it toward D. In like manner, the components of the forces of *r* and *s*, which solicit the north end of the needle in the directions PC

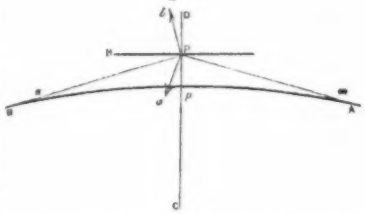
Fig. 2.



and PD, destroy each other. The same may be shown with regard to the actions upon the south end of the needle. It follows, therefore, that the needle will place itself at right angles to CPD, the isogeothermal line passing through P the station of the needle. This is a consequence from our theory which, like the formulæ soon to be investigated, is to be tested by making comparisons with observations.

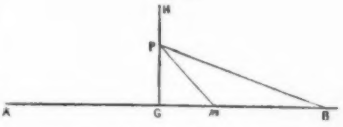
Let us now deduce from the general principles which have been laid down, the horizontal and vertical components of the directive force of the needle. Let A*p*B, fig. 3, represent a great circle of the earth, answering to *m*P*s*, or *n*P*r* in fig. 2, C*p* its radius, P the north end of a magnetic needle, and *m* *n* two particles of the earth situated at equal distances to the north and south of P. The action of *m* situated to the south of P, will be in the direction P*a* perpendicular to *m*P, and that of *n* will have the direction P*b* perpendicular to *n*P. The force P*a* may be decomposed into two forces having the directions PC and PH; and the force P*b* may be decomposed into two having the directions PD and PH. The sum of the two horizontal components will be the effective horizontal force due to the actions of *m* and *n*, and the difference of the two vertical components will be the effective vertical force due to the action of the same particles. Since the temperature of *m* is higher than that of *n*, the component directed from P to C is greater than that directed from P to D, and hence the north end of the needle will be urged downward. The horizontal force will solicit the north end of the needle toward the north. The actions upon the south end of the needle will be just the reverse. Now if we suppose the same process of decomposition to be gone through with for each pair of particles situated on AB at equal distances from P, up to a certain distance at which the molecular actions become insensible, by taking the sum of the individual forces along PC and PH, we shall have the entire effects of the arc AB in these two directions. In the same manner we may obtain the effects of any arc below AB and situated in the same plane; and thus the entire effect of all the matter situated in this plane which exerts any action upon the needle. Since the curvature of the arc AB is very slight, and P is very near to it, it is only the particles situated quite near to *p* that will have any material action in the horizontal direction. For arcs below the earth's surface the portion that furnishes the horizontal force will be greater as the depth increases, but will still, doubtless, be small in comparison with the more distant

Fig. 3.



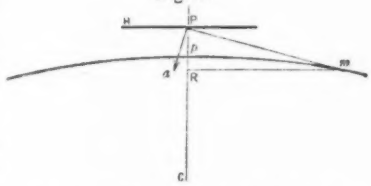
parts which act nearly in the vertical direction upon the needle. If, as we have supposed, the principle of magnetism be analogous in its nature to light and heat, then it must be more or less absorbed in its passage from the lower arcs to the surface; and there may be a gradual decrease in the extent of the arc which exerts a sensible action upon the needle, as the depth of the arc increases, until at the lower surface of the stratum of sensible action it becomes reduced to zero.

Fig. 4.



Formulas for the horizontal and vertical components of the directive force suited to our present enquiry, may be easily investigated. Let AB, fig. 4, be an isogeothermal line, and GH an arc of a great circle crossing this line perpendicularly and passing through P the station of the needle. The magnetic intensity of the particles of AB is every where the same. Take any particle m and designate the distance Pm, in a right line, by r. Either end of a needle at P will be solicited by a force perpendicular to Pm, and in the vertical plane through Pm. This force will be, for different isogeothermal lines, directly proportional to the magnetic intensity of m, and therefore to its mean annual temperature (t); and will, for the same isogeothermal line, vary from one particle to another with the distance r. Its expression will therefore be of the form $At.\varphi^*(r)$; A being an indeterminate constant. Now, let mp, fig. 5, represent the great circle immediately below mP in fig. 4, and lying either on the earth's surface or beneath it. We shall have force Pa(due to m) $= At.\varphi(r)$. The component of Pa in the direction of the radius or vertical PC will be equal to Pa . cos aPC $=$ Pa . sin mPR $=$ Pa . $\varphi'(r, h, \mathrm{R})$; R being the radius of the circle, which may be taken equal to the radius of the earth, and h the height Pp of the needle above the circle. We have therefore for the action of m in the direction of the vertical PC, the expression $At.\varphi(r).\varphi'(r, h)$; and when the height h is regarded as constant, we have $At.\varphi(r).\varphi'(r)$, or $At.f(r)$. To obtain the entire effect in the vertical direction of all the particles in the line GB, fig. 4, let GB be denoted by k, any portion Gm of it by x, and PG by l. The action of an elementary portion of GB will have for its expression $At.f(r)dx$

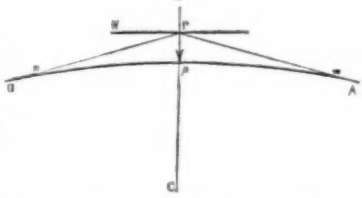
Fig. 5.



* The letters φ, f, F, with and without accents, are used in these investigations to designate different functions, and are therefore to be read "a function of."

$=Atf(\sqrt{l^2+x^2})dx$. Integrating this between the limits 0 and k, we have, vertical action of $GB=At.F(l, k)$. Whence, vertical action of $AB=2At.F(l, k)$. If k may be taken sensibly the same for different isogeothermal lines, this expression will become $2At.F(l)$. It is to be supposed, however, that the last particle of GB, which has a sensible action upon the needle at P, is at the same distance from this point whatever may be the distance of AB from it. The value of k will therefore be less, in proportion as the distance l is greater. Supposing the most remote particle to be at B, and denoting its distance PB by d, k will be equal to $\sqrt{d^2-l^2}$, and the above expression will become $2At.F(l,\sqrt{d^2-l^2})$, or $2At.F'(l)$. It follows therefore that the entire action of any isogeothermal line AB in the vertical direction upon a needle at P, may be reduced to a single force, proportional to the temperature, and varying from one isogeothermal line to another, with the distance PG of this line from the station of the needle. The entire effect of any single lamina of matter will therefore be the same as if the action was confined to the particles lying in the arc GPH; the effective force of each particle being proportional to its temperature, and also a certain function of its distance from the needle.

Fig. 6.



This being understood, let AB, fig. 6, represent an arc crossing the parallel isogeothermal lines at right angles, T the mean annual temperature of the earth at p the station of the needle, t and t' the mean temperatures at the extreme points A and B which have a sensible action upon the needle, u the difference between the mean temperature at p and at any point m, y the arc pm, a the arc pA, and r the distance Pm. pm or y may be regarded as depending for its value upon Pm, Pp, and Cp; of which Pp and Cp are constant for the same arc. Thus for any one arc, (representing, according to what has been shown, a single lamina,) $y=\varphi(r)$. If we regard the variation of temperature as uniform for the extent of the arc AB

$$u : t-T :: y : a. \therefore u=(t-T)\frac{y}{a}=(t-T)\frac{\varphi(r)}{a}.$$

Thus, temperature at $m=T+(t-T)\frac{\varphi(r)}{a}$.

Whence, putting $v=$ vertical force due to an element dy at m, and taking the expression for the action of an isogeothermal line, and incorporating the 2 with the constant A,

$$dv = \mathrm{A}\left(\mathrm{T} + (t-\mathrm{T})\frac{q(r)}{a}\right)\mathrm{F}'(r)dy = \mathrm{A}\left(\mathrm{T} + (t-\mathrm{T})\frac{q(r)}{a}\right)\mathrm{F}'(r)dq(r)$$

$$= \mathrm{AT}\,.\,\mathrm{F}'(r)dq(r) + \mathrm{A}(t-\mathrm{T})\frac{q(r)}{a}\mathrm{F}'(r)dq(r).$$

Integrating, $v = \mathrm{AT}\int \mathrm{F}'(r)dq(r) + \mathrm{A}(t-\mathrm{T})\int \frac{qr}{a}\mathrm{F}'(r)dq(r).$

Integrating between the limits Pp and PA, to obtain the force due to the arc pA, the two integrals will become two functions of Pp and PA. Now, for any supposed value of Pp, PA will be the same at every different place on the earth, and therefore the values of these integrals will be every where the same. If we denote them by M and N, we have

$$v = \mathrm{ATM} + \mathrm{A}(t-\mathrm{T})\mathrm{N} = \mathrm{AM}\,.\,\mathrm{T} + \mathrm{AN}(t-\mathrm{T}).$$

By the same process we obtain for the vertical force due to the arc pB $\qquad v' = \mathrm{AM}\,.\,\mathrm{T} + \mathrm{AN}(t'-\mathrm{T}).$

Hence the expression for the effect of the whole arc, AB, is

$$v - v' = \mathrm{AN}(t-t') = c(t-t') \quad . \quad . \quad . \quad (1.)$$

If we consider the action of a second lamina, the value of c may be different, but $t-t'$ will remain very nearly the same, except at considerable depths where the rate of variation of the temperature may be different, or the arc AB may be diminished by the absorption of the ethereal waves in their passage to the surface. If we neglect these possible variations of $t-t'$, and add together the actions of the different laminæ, we obtain for the actual vertical force

$$\mathrm{V} = \mathrm{C}(t-t') \quad . \quad . \quad . \quad (2.)$$

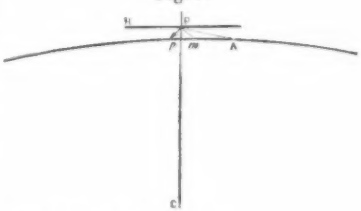
in which C is the sum of the values of c for the different laminæ. If we take account of the variations of $t-t'$, we shall have the actual force equal to the sum of a series of expressions of the form $c(t-t')$ in which both c and $t-t'$ will be more or less different. It would seem, however, that the changes in the value of $t-t'$, from absorption or other causes, must be very slight. In fact if the absorption be always a certain fractional amount of the intensity, there will be no change of $t-t'$ from this cause. It will only be necessary to regard c as varying. And if the absorption be always the same fractional amount whatever may be the intensity, c and therefore C will have the same value at different places.

The supposition made in the investigation of formula (2), that the variation of temperature is uniform for the extent of the arc AB, is not strictly true. From the equator to the latitude 45°, and even beyond this, the rate of diminution of the temperature for every degree of latitude continually increases. The effect of this will be to make the vertical component somewhat greater, except in the higher latitudes, than formula (2) would

give it, (that is, supposing C to be determined à priori. If C be determined from observations made at the point of maximum variation of temperature, the values of V given by equation (2) will be too small south of this point and too great north of it.)

To obtain a formula for the horizontal component of the directive force, we may proceed in the same manner as for the vertical component, except that we now multiply the force P*a*, fig. 5, by the cosine of the angle *a*PH instead of *a*PC. We shall therefore have for the entire action of the isogeothermal line AB, fig. 4, the expression $A't \cdot F''(l)$. Hence, that of all the isogeothermal lines, or of the whole acting surface, will be reduced to that of the single arc which crosses these lines at right angles; the magnetic intensity of the different points of this arc being proportional to the temperature, and the effective forces upon the needle varying according to some function of the distance. Now, as in the present enquiry all the active particles lie quite near to P, their temperatures may be considered the same and equal to that of the earth at the station of the needle: or, if there is a sensible variation at the lower layers, the augmentation towards the south will be compensated for by an equal diminution towards the north. Hence, designating the arc *pm*, fig. 7, by *y*, and the distance P*m* by *r*, the expression for the horizontal force due to this arc is

Fig. 7.



$$\int dh = \int A'T \cdot F''(r)dy = A'T \int F''(r)dq(r).$$

Integrating between the limits $r = Pp$ and $r = PA$, and designating the value of the integral by P, we have

$$H' = A'T \cdot P;\ 2H' = 2A'P \cdot T$$

and thus finally the total horizontal force

$$H = C'T \quad . \quad . \quad . \quad (3.)$$

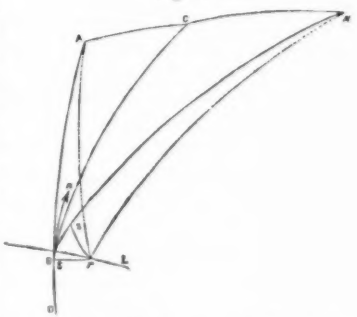
This is the expression for the entire effect of a single lamina. For different laminæ C′ may be different; and beyond a certain depth T will increase. If the supposed absorption of the magnetic emanations be a certain constant fractional amount of the magnetic intensity of the molecules, C′ will be every where the same. If we take the sum of all the equations (3) answering to the different laminæ, we shall have an equation of the same form for the horizontal component of the directive force, or the horizontal intensity at P. It is only by comparing the results furnished by this equation, with observations, that we can ascertain with certainty whether T is to be taken sensibly different from the mean surface temperature, and whether C′ may be regarded as truly constant for all places.

It remains to investigate a formula for the declination of the needle. We have already seen that the magnetic needle is every where at right angles to the line of equal molecular magnetic intensity traced upon the earth through its station; which line we have assumed to be the same as the isogeothermal line passing through the same point. We have therefore only to seek for a formula which shall make known the direction of the isogeothermal line at a given place and place the needle at right angles to this line of direction. Such a formula may be derived from Brewster's formula for the determination of the mean annual temperature of a place. This is

$$\mathrm{T}=(t-\tau)(\sin^{n}\delta\,.\,\sin^{n}\delta')+\tau \quad . \quad . \quad (4.)$$

where t is the maximum equatorial temperature, τ the minimum temperature at each of the two poles of maximum cold, and δ, δ' the distances of the place from the two cold poles. Let C, fig. 8, represent the north pole of the earth, A and A′ the two poles of greatest cold, B a given place, BL the direction of the isogeothermal line through B. BA$=\delta$, and BA′$=\delta'$. For the isogeothermal line, since T is constant, $d\mathrm{T}=0$. Hence, if we differentiate equation (4), and put the differential equal to zero, we shall have a relation between $d\delta$ and $d\delta'$, the variations of δ and δ' in passing from the point B to its consecutive point r on the isogeothermal line. Thus, putting $t-\tau=c$, we have

Fig. 8.



$$d\mathrm{T}=c(n\sin^{n-1}\delta\cos\delta\sin^{n}\delta' d\delta+n\sin^{n-1}\delta'\cos\delta'\sin^{n}\delta d\delta').$$

Multiplying and dividing by $\sin^{-n+1}\delta\sin^{-n+1}\delta'$,

$$d\mathrm{T}=\frac{c(n\cos\delta\sin\delta' d\delta+n\cos\delta'\sin\delta d\delta')}{\sin^{-n+1}\delta\sin^{-n+1}\delta'}=0.$$

Hence, $\cos\delta\sin\delta' d\delta+\cos\delta'\sin\delta d\delta'=0$

$$\text{And,}\quad \frac{d\delta}{d\delta'}=-\frac{\sin\delta\cos\delta'}{\cos\delta\sin\delta'} \quad . \quad . \quad . \quad (5.)$$

If we drop the perpendiculars rs and rt upon BA′ and BA produced, we have B$t=d\delta$, and B$s=d\delta'$. Put B$r=k$, angle rB$t=a$, and angle rB$s=a'$. If in the angle A′BD we conceive two arcs to be drawn through B respectively perpendicular to BA′ and BD, the isogeothermal line will lie some where between these two perpendiculars; for it is only in this situation that in passing from

B to r it can happen that δ will be increased and δ' diminished, and therefore that $\sin^n\delta \sin^n\delta'$, in formula (4), can remain the same. Now $Bs = Br \cos rBs$, or $d\delta' = k \cos a'$; and $Bt = Br \cos rBt$, or $d\delta = k \cos a$. Hence $\frac{d\delta}{d\delta'} = \frac{\cos a}{\cos a'}$; and, by equation (5), neglecting the minus sign; putting also u = angle A′BD,

$$\frac{\sin\delta\cos\delta'}{\cos\delta\sin\delta'} = \frac{\cos a}{\cos a'} = \frac{\cos a}{\cos(u-a)},$$

or,

$$\frac{\sin\delta\cos\delta'}{\cos\delta\sin\delta'} = \frac{\cos a}{\cos u\cos a + \sin u\sin a} = \frac{1}{\cos u + \sin u \tan a}.$$

Whence,

$$\tan a = \frac{\sin\delta'\cos\delta - \sin\delta\cos\delta'\cos u}{\sin\delta\cos\delta'\sin u},$$

or,

$$\tan a = \frac{\cot\delta\tan\delta'}{\sin u} - \cot u.$$

If we put β = ABA′ $u = 180 - \beta$, and

$$\tan a = \frac{\cot\delta\tan\delta'}{\sin\beta} + \cot\beta \quad . \quad . \quad . \quad (6.)$$

This formula gives the angle DBL. Subtracting this from 90° we obtain nBA, the angle included between the direction of the needle and BA(δ). The difference between this and ABC will be the declination of the needle, which will be east or west, according as one or the other of these angles is the greater.

The first of the equations above gives the following, which may be used as a tentative formula in place of equation (6):—

$$\frac{\cos a}{\cos(u-a)} = \frac{\tan\delta}{\tan\delta'} \quad . \quad . \quad . \quad . \quad (7.)$$

To make use of formula (6) we must know δ, δ', and β. These may be obtained by solving the two spherical triangles ACB, A′CB. The latitude and longitude of the place B, and the latitudes and longitudes of the two poles A and A′ being given, we readily find CB, AC, and A′C, and the angles ACB, A′CB.

The formulæ which have now been investigated, viz. (2), (3), and (6), serve for the determination of the vertical and horizontal intensities at any place, and the declination of the needle. By taking the square root of the sum of the squares of the horizontal and vertical intensities, we shall have the directive force or total magnetic intensity of the place; and by dividing the vertical by the horizontal intensity we shall have the tangent of the dip.

These formulæ I have compared with a large number of observations made in various parts of the northern hemisphere, and will proceed to give an exposition of the details of the calculations, and of the results obtained.

(*To be continued.*)

ART. II.—*General Geological Distribution and probable Food and Climate of the Mammoth;* by Prof. R. OWEN.*

THE remains of the Mammoth occur on the Continent, as in England, in the superficial deposits of sand, gravel, and loam, which are strewed over all parts of Europe; and they are found in still greater abundance in the same formations of Asia, especially in the higher latitudes, where the soil which forms their matrix is perennially frozen.† Remains of the Mammoth have been found in great abundance in the cliffs of frozen mud on the east side of Behring's Straits, in Eschscholtz's Bay, in Russian America, 66° N. lat.; and they have been traced, but in scantier quantities, as far south as the states of Ohio, Kentucky, Missouri, and South Carolina. But no authentic relics of the Elephas primigenius have yet been discovered in tropical latitudes,‡ or in any part of the southern hemisphere. It would thus appear that the primeval Elephants formerly ranged over the whole northern hemisphere of the globe, from the 40th to the 60th, and possibly to near the 70th degree of latitude. Here at least, at the mouth of the river Lena, the carcass of a Mammoth has been discovered, preserved entire, in the icy cliffs and frozen soil of that coast. To account for this extraordinary phenomenon, geologists and naturalists, biased more or less by the analogy of the existing Elephants, which are restricted to climes where the trees flourish with perennial foliage, have had recourse to the hypothesis of a change of climate in the northern hemisphere, either sudden, and due to a great geological cataclysm,§ or gradual, and brought about by progressive alterations of land and sea.‖

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* Extracted from Prof. Owen's British Fossil Mammalia, 8vo. London, 1846.

† Hedenström, in his "Survey of the Laechow Islands," on the north-eastern coast of Siberia, remarks, "that the first of these islands is little more than one mass of these bones; and that although the Siberian traders have been in the habit of bringing over large cargoes of them (tusks) for upwards of sixty years, yet there appears to be no sensible diminution."

‡ The fossil elephantine remains discovered in India, belong to a species more nearly allied to the Elephas indicus.

§ Cuvier, "Discours sur les Révolutions de la Surface du Globe." It is obvious that the frozen Mammoth at the mouth of the Lena, forms one of the strongest, as well as the most striking, of the celebrated anatomist's assumed "proofs that the revolutions on the earth's surface had been sudden." Cuvier affirms that the Mammoth could not have maintained its existence in the low temperature of the region where its carcass was arrested, and that at the moment when the beast was destroyed, the land which it trod became glacial. "Cette gelée éternelle n'occupait pas auparavant les lieux où ils ont été saisis; car ils n'auraient pas pu vivre sous une pareille température. C'est donc le même instant qui a fait périr les animaux, et qui a rendu glacial le pays qu'ils habitaient. Cet événement a été subis, instantané, sans aucune gradation, &c."—*Ossemens Fossiles*, 8vo, ed. 1834, tom. i, p. 108.

‖ Lyell, "Principles of Geology," in which the phenomena that had been supposed "to have banished for ever all idea of a slow and gradual revolution,"* were first attempted to be accounted for by the gradual operation of ordinary and existing causes.

* Jameson's "Cuvier's Theory of the Earth," 8vo, p. 16, 1813.

I am far from believing that such changes in the external world were the cause of the ultimate extinction of the Elephas primigenius; but I am convinced that the peculiarities in its ascertained organization, are such as to render it quite possible for the animal to have existed as near the pole as is compatible with the growth of hardy trees or shrubs. The fact seems to have been generally overlooked, that an animal organized to gain its subsistence from the branches or woody fibre of trees, is thereby rendered independent of the seasons which regulate the development of leaves and fruit; the forest food of such a species becomes as perennial as the lichens that flourish beneath the winter snows of Lapland; and, were such a quadruped to be clothed, like the Reindeer, with a natural garment capable of resisting the rigors of an arctic winter, its adaptation for such a climate would be complete. Had our knowledge of the Mammoth, indeed, been restricted, as in the case of almost every other extinct animal, to its bones and teeth, it would have been deemed a hazardous speculation to have conceived, a priori, that the extinct ancient Elephant, whose remains were so abundant in the frozen soil of Siberia, had been clad, like most existing quadrupeds adapted for such a climate, with a double garment of close fur and coarse hair; seeing that both the existing species of Elephants are almost naked, or, at least, scantily provided when young with scattered coarse hairs of one kind only.

The wonderful and unlooked for discovery of an entire Mammoth, demonstrating the arctic character of its natural clothing, has, however, confirmed the deductions which might have been legitimately founded upon the localities of its most abundant remains, as well as upon the structure of its teeth, viz., that, like the Reindeer and Musk Ox of the present day, it was capable of existing in high northern latitudes.

The circumstances of this discovery have been recorded by Mr. Adams in the 'Journal du Nord,' printed at Petersburg in 1807, and in the 5th volume of the 'Memoirs of the Imperial Academy of Sciences at St. Petersburg,' of which an excellent English translation was published in 1819.

Schumachoff, a Tungusian hunter and collector of fossil ivory, who had migrated in 1799 to the peninsula of Tamut, at the mouth of the river Lena, one day perceived amongst the blocks of ice a shapeless mass, not at all resembling the large pieces of floating wood which are commonly found there. To observe it nearer, he landed, climbed up a rock, and examined this new object on all sides, but without being able to discover what it was. The following year he perceived that the mass was more disengaged from the blocks of ice, and had two projecting parts. Towards the end of the next year, (1801,) the entire side of the animal and one its tusks were quite free from the ice. On his re-

turn to the borders of the Lake Oncoul, he communicated this extraordinary discovery to his wife and some of his friends, but their reception of the news filled him with grief. The old men related how they had heard their fathers say, that a similar monster had been formerly discovered on the same peninsula, and that all the family of the person who had discovered it had died soon afterwards. The Mammoth was consequently regarded as an augury of future calamity, and the Tungusian was so much alarmed that he fell seriously ill; but becoming convalescent, his first idea was the profit he might obtain by selling the tusks of the animal, which were of extraordinary size and beauty. The summer of 1802 was less warm and more stormy than usual, and the icy shroud of the Mammoth had scarcely melted at all. At length, towards the end of the fifth year, (1803,) the desires of the Tungusian were fulfilled; for, the parts of the ice between the earth and the Mammoth having melted more rapidly than the rest, the plane of its support became inclined, and the enormous mass fell by its own weight on a bank of sand. Of this, two Tungusians who accompanied Mr. Adams were witnesses. In the month of March, 1804, Schumachoff came to his Mammoth, and having cut off the tusks, exchanged them with a merchant, called Bultunoff, for goods of the value of fifty rubles.

Two years afterwards, or the seventh after the discovery of the Mammoth, Mr. Adams visited the spot, and "found the Mammoth still in the same place, but altogether mutilated. The prejudices being dissipated because the Tungusian chief had recovered his health, there was no obstacle to prevent approach to the carcass of the Mammoth; the proprietor was content with his profit from the tusks; and the Jakutski of the neighborhood had cut off the flesh, with which they fed their dogs during the scarcity. Wild beasts, such as white bears, wolves, wolverines, and foxes, also fed upon it, and the traces of their footsteps were seen around." The skeleton, almost entirely cleared of its flesh, remained whole with the exception of one foreleg, (probably dragged off by the bears.) The spine, from the skull to the os coccygis, one scapula, the pelvis, and the three remaining extremities, were still held together by the ligaments and by parts of the skin. The head was covered with a dry skin; one of the ears, well preserved, was furnished with a tuft of hair. The point of the lower lip had been gnawed; and the upper one, with the proboscis, having been devoured, the molar teeth could be perceived. The brain was still in the cranium, but appeared dried up: the parts least injured were one forefoot and one hindfoot: they were covered with skin, and still had the sole attached. According to the assertion of the Tungusian discoverer, the animal was so fat, that its belly hung down below the joints of the knees. This Mammoth was a male, with a long mane on the

neck; the tail was much mutilated, only eight, out of twenty-eight or thirty caudal vertebræ, remaining; the proboscis was gone, but the places of the insertion of its muscles were visible on the skull. The skin, of which about three-fourths were saved, was of a dark grey color, covered with a reddish wool, and coarse long black hairs. The dampness of the spot where the animal had lain so long, had in some degree destroyed the hair. The entire skeleton, from the fore part of the skull to the end of the mutilated tail, measured sixteen feet four inches; its height was nine feet four inches. The tusks measured along the curve nine feet six inches, and in a straight line from the base to the point, three feet seven inches.

Mr. Adams collected the bones, and had the satisfaction to find the other scapula, which had remained, not far off. He next detached the skin on the side on which the animal had lain, which was well preserved; the weight of the skin was such, that ten persons found great difficulty in transporting it to the shore. After this, the ground was dug in different places to ascertain whether any of its bones were buried, but principally to collect all the hairs which the white bears had trod into the ground while devouring the flesh; and more than thirty-six pounds' weight of hair were thus recovered. The tusks were repurchased at Jatusk, and the whole expedited thence to St. Petersburg; the skeleton is now mounted in the museum of the Petropolitan Academy.*

It might have been expected that the physiological consequences deducible from the organization of the extinct species, which was thus in so unusual a degree brought to light, would have been at once pursued to their utmost legitimate boundary, in proof of the adaptation of the Mammoth to a Siberian climate; but, save the remark that the hairy covering of the Mammoth must have adapted it for a more temperate zone than that assigned to existing Elephants,† no further investigations of the relation of its organization to its habits, climate, and mode of life,

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* A part of the skin and some of the hair of this animal, were sent by Mr. Adams to Sir Joseph Banks, who presented them to the Museum of the Royal College of Surgeons. The hair is entirely separated from the skin, excepting in one small part, where it still remains firmly attached. It consists of two sorts, common hair and bristles; and of each there are several varieties, differing in length and thickness. That remaining fixed on the skin is thick-set and crisply curled; it is interspersed with a few bristles, about three inches long, of a dark reddish color. Among the separate parcels of hair are some rather redder than the short hair just mentioned, about four inches long, and some bristles nearly black, much thicker than horse-hair, and from twelve to eighteen inches long. The skin when first brought to the Museum, was offensive to the smell. It is now quite dry and hard, and where most compact is half an inch thick. Its color is the dull black of the living Elephant.

† "La longue toison dont cet animal était convert semblerait même démontrer, qu'il était organisé pour supporter un degré de froid plus grand que celui qui convient à l'éléphant de l'Inde."—*Pictet, Paleontologie*, 8vo, tom. i, p. 71, 1844.

appear to have been instituted; they have in some instances, indeed, been rather checked than promoted.

Dr. Fleming has observed, that "no one acquainted with the gramineous character of the food of our Fallow-deer, Stag, or Roe, would have assigned a lichen to the Reindeer." But we may readily believe that any one cognizant of the food of the Elk, might be likely to have suspected cryptogamic vegetation to have entered more largely into the food of a still more northern species of the deer tribe. And I can by no means subscribe to another proposition by the same eminent naturalist, that "the kind of food which the existing species of Elephant prefers, will not enable us to determine, or even to offer a probable conjecture concerning that of the extinct species." The molar teeth of the Elephant possess, as we have seen, a highly complicated and a very peculiar structure, and there are no other quadrupeds that derive so great a proportion of their food from the woody fibre of the branches of trees. Many mammals browse the leaves; some small rodents gnaw the bark; the Elephants alone tear down and craunch the branches, the vertical enamel plates of their huge grinders enabling then to pound the tough vegetable tissue and fit it for deglutition. No doubt the foliage is the most tempting, as it is the most succulent part of the boughs devoured; but the relation of complex molars to the comminution of the coarser vegetable substance is unmistakeable. Now if we find in an extinct Elephant the same peculiar principle of construction in the molar teeth, but with augmented complexity, arising from a greater number of the triturating plates and a greater proportion of the dense enamel, the inference is plain that the ligneous fibre must have entered in a larger proportion into the food of such extinct species. Forests of hardy trees and shrubs still grow upon the frozen soil of Siberia, and skirt the banks of the Lena as far north as latitude 60°. In Europe, arboreal vegetation extends ten degrees nearer the pole, and the dental organization of the Mammoth proves that it might have derived subsistence from the leafless branches of trees, in regions covered during a great part of the year with snow.

We may therefore safely infer from physiological grounds, that the Mammoth would have found the requisite means of subsistence at the present day, and at all seasons, in the sixtieth parallel of latitude; and relying on the body of evidence adduced by Mr. Lyell in proof of increased severity in the climate of the northern hemisphere, we may assume that the Mammoth habitually frequented still higher latitudes at the period of its actual existence. "It has been suggested," observes the same philosophic writer, "that, as in our own times, the northern animals migrate, so the Siberian Elephant and Rhinoceros may have wandered towards the north in summer." In making such excursions during the

heat of that brief season, the Mammoths would be arrested in their northern progress by a condition to which the Reindeer and Musk Ox are not subject, viz. the limits of arboreal vegetation, which, however, as represented by the dominating shrubs of Polar lands, would allow them to reach the seventieth degree of latitude.* But, with this limitation, if the physiological inferences regarding the food of the Mammoth from the structure of its teeth be adequately appreciated and connected with those which may be legitimately deduced from the ascertained nature of its integument, the necessity of recurring to the forces of mighty rivers hurrying along a carcass through a devious course, extending through an entire degree of latitude, in order to account for its ultimate entombment in ice, whilst so little decomposed as to have retained the cuticle and hair, will disappear. And it can no longer be regarded as impossible for herds of Mammoth to have obtained subsistence in a country like the southern part of Siberia where trees abound, notwithstanding it is covered during a great part of the year with snow, seeing that the leafless state of such trees during even a long and severe Siberian winter, would not necessarily unfit their branches for yielding sustenance to the well-clothed Mammoth.

With regard to the extension of the geographical range of the Elephas primigenius into temperate latitudes, the distribution of its fossil remains, teaches that it reached the fortieth degree north of the equator. History, in like manner, records that the Reindeer had formerly a more extensive distribution in the temperate latitudes of Europe than it now enjoys. The hairy covering of the Mammoth concurs, however, with the localities of its most abundant remains, in showing that, like the Reindeer, the northern extreme of the temperate zone was its metropolis.

Attempts have been made to account for the extinction of the race of northern Elephants, by alterations in the climate of their hemisphere, or by violent geological catastrophes, and the like extraneous physical causes. When we seek to apply the same hypothesis to explain the apparently contemporaneous extinction of the gigantic leaf-eating Megatherian of South America, the geological phenomena of that continent appear to negative the occurrence of such destructive changes. Our comparatively brief experience of the progress and duration of species within the historical period, is surely insufficient to justify, in every case of extinction, the verdict of violent death. With regard to many of the larger Mammalia, especially those which have passed away from the American and Australian continents, the absence of suffi-

* In the extreme points of Lapland, in 70° north latitude, the pines attain the height of sixty feet; and at Enontekessi, in Lapland, in 68° 30′ north latitude, von Buch found corn, orchards, and a rich vegetation at an elevation of 1356 feet above the sea.—*Lindley, Intr. to Botany,* pp. 435, 490.

cient signs of extrinsic extirpating change or convulsion, makes it almost as reasonable to speculate with Brocchi,* on the possibility that species like individuals may have had the cause of their death inherent in their original constitution, independently of changes in the external world, and that the term of their existence, or the period of exhaustion of the prolific force, may have been ordained from the commencement of each species.

ART. III.—*Note upon Carex loliacea*, Linn., *and C. gracilis*, Ehrh.; by A. GRAY.

UNDER the name of *Carex loliacea*, two distinct species have long been confounded, which, although they have been of late to some extent distinguished, yet their history and synonymy still require elucidation.

Linnæus established his *C. loliacea* upon a Swedish plant, indicated in the *Flora Suecica*, No. 840, to which the specific name was first applied in the *Species Plantarum*, with the phrase: "C. spiculis subovatis sessilibus remotis androgynis, capsulis ovatis teretiusculis muticis divaricatis." He further describes it as having from four to eight small ovate spikelets scattering at the apex of the culm, and the perigynia "ovate, obtuse, pointless, and rounded on the lower side;" and proceeds to compare it with C. muricata, (which as to the *Flora Suecica*, is stated by Wahlenberg to be the C. stellulata, *Good.*,) from which it is said to differ in its smaller size, and in the less divaricate obtuse fruit. I suppose that there is no authentic specimen preserved in the Linnæan herbarium.

In the year 1802, Schkuhr figured† and described what he, with much hesitation, took for C. loliacea, remarking however that this Linnæan species was a very doubtful plant, and that what he had taken for it was probably only a variety of C. muricata; which seems to have been the case.

In the next year the real C. loliacea was, as I suppose, correctly taken up by Wahlenberg, a botanist most likely to know the Linnæan plant, who well characterized it as follows: "C. spiculis *basi masculis* subdistantibus ternis paucifloris, squamis brevibus, *capsulis subovali-ellipticis utrinque convexiusculis obtusis obtusangulis* divaricatis, ore integerrimo, bracteolis setigeris, foliis angustissimis."‡

In 1805, Willdenow gave a new phrase, viz. "C. spica androgyna composita, spiculis subquaternis inferne masculis subapproximatis, stigmatibus binis, *fructibus ellipticis obtusis nervosis com-*

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* Cited by Lyell, "Principles of Geology," (1835,) vol. iii, p. 104.
† Reidgr. t. Ee, No. 91. ‡ Wahlenb. in Act. Holm. 1803. p. 147.

pressis erectis."* This character was evidently drawn from the specimen in his herbarium marked fol. 2, the source of which is not recorded, and from which Kunth has also recently derived an additional description of C. loliacea; while the fol. 1, holds a Swedish specimen of a different plant, sent by Swartz under the name of C. loliacea, which (judging from a memorandum made on inspection several years ago) is most probably the C. tenella of *Schkuhr*. This C. tenella, Willdenow remarks, is the same as C. loliacea, but is incorrectly delineated and described by Schkuhr as having the spikelets masculine at the summit. Here is the beginning of the confusion, soon further complicated by Schkuhr himself, in which these two very distinct species have ever since been involved.

Schkuhr established and figured his *C. tenella*, in the first part of his work on Carices, in 1802, (No. 15, t. Pp, f. 104,) upon a plant which he found in the herbarium of a friend, who was entirely ignorant of its source, or even whether he had collected it himself or received it from a correspondent. This friend, as he elsewhere states, was Hedwig. Schkuhr's herbarium shows that he subsequently received the same species from Sweden, through Thunberg, ticketed "C. loliacea, *Linn.* In Nordlandia Norvegiæ rarius, per Nordlandiam Sueciæ copiose." In the same work, Schkuhr also figured (t. E, f. 24) a plant of unrecorded origin, which he took for the C. gracilis of "*Ehrhart, Gram.* [*Phytophylac?*] 78." The specimen which Schkuhr figured is not preserved in his herbarium; but in a paper fixed to the folio under this name, marked "Saamen," I found the very perigynium and achenium (*i. e.*) separately delineated in his figure. The perigynium is distinctly beaked, the staminate flowers are plainly depicted as occupying the summit of the spikelets, and the whole figure so nearly agrees with the smaller states of *C. rosea*, that I can scarcely doubt it was derived from that plant. In place of the specimen actually figured, the herbarium of Schkuhr contains one with a printed ticket, "C. gracilis, *Ehrh.:* Upsal," which is probably an authentic specimen from Ehrhart's original collection, but which, as it certainly is not the plant which Schkuhr has depicted, I suppose to have been received at a later period, and that the specimen which served for the figure in question was then discarded.

On obtaining possession of this authentic specimen (as I take it to be) of Ehrhart's *C. gracilis*, Schkuhr could not fail to perceive that it was precisely the same species with his own C. tenella, and with what had already been sent him from Sweden under the name of C. loliacea. Accordingly, in his Supplement, (1806,) he united the two, (but without explaining the

* Wild. Sp. Pl. 4, p. 237.

mistake he had made in figuring as C. gracilis, something different from the Ehrhartian plant;) and, following the cue which had been given him by Swartz, Willdenow, and Thunberg, erroneously referred them both to C. loliacea, *Linn.* Under that species, consequently, these two synonyms have been generally cited ever since, notwithstanding the discrepancy in the position of the staminate flowers, which in C. gracilis, *Ehrh.*, (C. tenella, *Schk.*,) are *correctly* described by Schkuhr as at the apex; while those of C. loliacea are rightly characterized by Wahlenberg and Willdenow, and indeed by all succeeding writers, as occupying the base of the spikelets: and the difference in the perigynia, &c. of the two species is not less decisive. Yet even Wahlenberg has unguardedly adduced the synonym in his Flora Lapponica; where he has given a further and most excellent account of the genuine C. loliacea, particularly contrasting it with his own C. tenuiflora, which is indeed the nearest related species. He notices the "*squamæ albicantes, omnium tenuissimæ*," and well describes the perigynia as follows: "Capsulæ in singula spicula 3 vel 4, ita obtusæ ut apice fere rotundatæ, utrinque convexiusculæ nervosæ, ob formam suam seminibus *Lolii temulenti* haud dissimiles, ut nomen omnino bonum."*

While the C. loliacea, *Linn.*, is, so far as I am aware, restricted to the north of Europe, the C. gracilis, *Ehrh.* has apparently a wider range and is much more abundant in the new world than in the old. It is the well-known *C. disperma*, of Dewey; who, while he noted its resemblance to C. loliacea, *Schk.*, (tenella, *Schk.*,) conceived it to be distinct by its terminal staminate flowers—a point in which it does indeed differ from the true C. loliacea, but not from the plant which Schkuhr mistook for it.

The two plants are so distinct in appearance and character, that the wonder is they should have been so long confounded. But I know of only two botanists who have distinguished them, namely, Nylander and Mr. Tuckerman. As to the former, my information is indirect. Ruprecht, in his recent critical enumeration of the plants which grow around St. Petersburg, has a "*Carex tenella*, Schkuhr, et Fl. Petropol. Bene diversa est a C. loliacea, L., utrasque exposuit cl. Nylander in *Spic. Fl. Fenn.*, ii, No. 92 et 93."† I have no acquaintance with the work of Nylander here cited, nor do I know its date; but I possess, through the kindness of Dr. Fischer, specimens ticketed "*Carex pulchella*, Nylander: ad oppidum Sardavalæ, Finlandiæ," which exactly accord with the American C. disperma, and, so far as recollection

* Wahl. Fl. Lapp., p. 232.—In his Flora Suecica, he further adds, that the "capsules are a line and a half long," which is fully one-third longer than are those of C. gracilis.

† In Historiam Stirp. Fl. Petropol. Diatribæ, p. 84. 1845.

and memoranda may be trusted, with the "C. gracilis, *Ehrh.*, Upsal," in Schkuhr's herbarium.

Mr. Tuckerman, in his *Enumeratio Caricum*, (1843,) p. 19, rightly remarks, that the C. loliacea of Schkuhr is scarcely that of Wahlenberg and Fries; and he inclines to the opinion, that the specimen from which Schkuhr figured his C. tenella, out of Hedwig's herbarium, was received by Hedwig from Muhlenberg, and therefore may directly represent the American plant. This is not unlikely; but Mr. Tuckerman does not appear to have been aware that this species is also a native of the north of Europe, and had been gathered at least as early as the year 1780. He justly remarks, also, that it is scarcely credible that Schkuhr's figures 24 and 104, can belong to the same species. I have already given what I believe to be the explanation of this incongruity.

It would therefore appear that the synonymy of the two species in question should stand as follows:

1. C. LOLIACEA, *Linn.; Wahl.; Fl. Dan.*, t. 1403; *Kunth*, (excl. syn. C. tenella and C. gracilis, *Schk.*,) not of *Schk. Car. No.* 14, f. 91, nor *Suppl. No.* 47, p. 18.

2. C. GRACILIS, Ehrh.; not of *Schk. Car.*, f. 24, nor of *R. Br.* C. tenella, Schk. Car., f. 104. C. loliacea, *Schk. Car. Suppl.*, p. 18; not of *Linn., etc.* C. disperma, *Dewey;* not of *Kunze, Car.*, t. 33.*

ART. IV.—*Description of Three New Carices, and a New Species of Rhynchospora;* by JOHN CAREY.

CAREX GRAYII: spica mascula solitaria pedunculata; spicis fœmineis 2 globosis densi-(25–30-) floris exserte pedunculatis; stigmatibus 3; perigyniis deflexo-patentibus ovatis ventricosis multi-nervosis rostratis ore bifidis squamam ovatam hyalinam mucronatam triplo longioribus.—C. intumescens, var. β. globularis, *A. Gray, in Ann. Lyc. Nat. Hist. N. Y.*, iii, 236.

Hab. Ad ripas fluminum "Mohawk" et "Wood-creek," Nov. Ebor. occident. detexit cl. A. Gray, M.D.

Culm 3 feet high, robust, triquetrous, smooth and leafy. Leaves taller than the culm, 4–5 lines broad, rough on the margin. Sterile spike 1½–2 inches long: fertile spikes globular, occasionally single, but generally 2, quite distinct and separate, 1½ inch in diam-

* The figure which Prof. Kunze has given as *C. disperma*, from specimens gathered on the Black Mountain of North Carolina by Rugel, is an entirely different species; namely, the C. rosea, var. radiata, *Dewey*, (C. neglecta, *Tuckerm.*,) or very near it—a plant which I have myself gathered on the mountains of Carolina, very far south of the known range of the species for which this excellent Caricologist has unaccountably mistaken it.

eter. Perigynia crowded, deflexed, smooth and shining, 9 lines in length, 25–30 nerved, tapering into a long perfectly glabrous beak. Achenium obtusely triangular, minutely dotted under a lens, crowned with the long continuous style.

Dr. Gray, who first detected this plant on the banks of the Mohawk at Utica, and described it as a variety of C. intumescens, *Rudge*, remarks, that it "is characterized by its larger and coarser habit, and by its globose, many-flowered pistillate spikes. It flowers a month later than the ordinary form of the species, and when young might readily be mistaken for C. lupulina." To this may be added, that C. intumescens, owing to the scarcely exserted peduncles, has the loose, few- (5–8-) flowered spikes closely approximate, so as to be almost indistinguishable; and the perigynia are erect, much shorter, (6–7 lines long,) slightly serrulate towards the apex of the beak, and only 15–20-nerved. Though closely resembling C. intumescens, these constant characters and a marked difference in aspect, appear to entitle this plant to rank as a species.*

CAREX PLATYPHYLLA: spicis 4; mascula 1 erecta gracili pedunculata; fœmineis 3 erectis filiformibus laxe 3–4-floris incluse pedunculatis, suprema masculæ approximata, cæteris remotis folioso-bracteatis; bracteis spicas paulo superantibus; stigmatibus 3; perigyniis triquetris ovalibus striatis brevissime rostellatis squamam ovatam hyalinam acutam vel mucronatam subæquantibus, ore obliquo integro.

Hab. In declivibus umbrosis, Nov. Angl. et Nov. Ebor.

Culms numerous, leafless, 8–12 inches long, slender, somewhat ancipital, smooth, diffusely spreading and prostrate in fruit. Leaves all radical, ½–1 inch in breadth, 4–6 inches long, flat, pale green or whitish, striate throughout with very fine and close nerves, three of them more conspicuous. Fertile spikes generally 3, erect, ½–¾ of an inch in length, with a few distant alternate flowers, subtended by leafy sheathing bracts, which are not much longer than the spikes. Perigynia triquetrous, finely striate, narrowed at the apex, with a minute oblique point: scale of a light chestnut color, with a green keel and scarious margins.

This plant, though not uncommon in shady ravines, has been hitherto confounded either with the large leaved form of C. anceps, *Muhl.*, or with C. retrocurva, *Dew.*, from both of which, however, it is quite distinct. It forms, with C. plantaginea, *Lam.*, and C. Careyana, *Dew.*, a well marked subsection, (*Plantagineæ*,) which may be characterized by the few-flowered, erect fertile spikes, the upper usually close to the barren one, all on

* Since the foregoing description was in type, I have seen specimens from Columbus, Ohio, collected by Mr. Sullivant.

short peduncles nearly included within the small sheathing bracts, or the lower partly exserted; and by the triquetrous fruit; numerous, leafless, diffuse, and at length prostrate culms; and broad radical leaves. In the varying forms of C. anceps, the perigynium is constantly more obtuse on the angles, and more obovate in outline; and the bracts are always long and leafy, the upper exceeding the culm. In C. digitalis, *Willd.*, and the closely allied C. retrocurva, the leaves and bracts are also long and grassy, commonly exceeding the culms, and the lower spikes are generally on much-exserted, filiform, more or less pendulous peduncles. The perigynium of the present species, the smallest of the group here indicated, closely resembles that of C. digitalis.

Carex sychnocephala: spicis androgynis inferne masculis crebris arcte capitato-aggregatis folioso-bracteatis; stigmatibus 2; perigyniis compressis e basi ovato-lanceolata abrupte contracta subsessili longe sensimque rostratis apice bifidis margine scabris squamam hyalinam lanceolatam abrupte mucronatam paulo longioribus.—C. cyperoides, *Dew., in Am. Jour. of Sc. and Arts*, iii, 171, non *L.*

Hab. In Nov. Ebor. Comitat. "Jefferson," ubi legerunt cl. I. B. Crawe, M.D., et cl. W. A. Wood, M.D.

Culm about a foot high, leafy, smooth; spikes sessile, densely clustered, forming a compound capitate spike subtended by 3 long unequal foliaceous bracts much exceeding the spike. Perigynium tapering from an abruptly contracted ovate base into a long and slender scabrous bifid beak, a little exceeding the lanceolate abruptly mucronate scale. Achenium ovate, compressed, crowned with the lengthened style.

This plant, which has a great resemblance to C. cyperoides, *Linn.*, differs from that species in the nearly sessile perigynium, which tapers from a much wider and contracted (not attenuated) base into a shorter beak, of which the teeth are also shorter than in the European plant. The perigynia are more crowded on the rachis than in C. cyperoides, the spikes of which, owing to the greater length of the beaks, have a more comose appearance than in our plant. The scale is shorter, abruptly mucronate, and not gradually tapering as in C. cyperoides; and the achenium is ovate, not ovate-oblong, as in that species.

I may here mention that, amongst the undetermined species of Carex in the rich herbarium of my friend, Prof. Gray, I find C. vulpina, *L.*, collected at, or near Columbus, Ohio, by Mr. Sullivant; and also a single specimen from Illinois, communicated by Dr. Engelmann of St. Louis. They correspond perfectly with the European plant, and the species may possibly be common in the Western States, where it may have been hitherto confounded with the nearly allied, though very distinct, C. stipata, *Muhl.*

RHYNCHOSPORA KNIESKERNII: culmo trigono gracili; spicis numerosis in glomerulis 4–6 distantibus aggregatis; nuce lævi obovata substipitata setas 6 retrorsum hispidas æquante tuberculo triangulari subduplo longiore.

Hab. In pinetis Nov-Cæsar., detexit cl. P. D. Knieskern, M.D.

Culm 12–18 inches high, branching from the base, slender, nearly smooth: leaves short and narrow. Spikes small, setaceously bracteate, forming small distant clusters throughout the entire length of the culm, each subtended by a long foliaceous bract. Nut obovate, lenticular, attenuate at the base. Tubercle compressed, broad at the base, about half the length of the nut.

In its characters this species is closely allied to R. capillacea, *Torr.*, from which, however, it is readily distinguished by the shorter and more numerous aggregated spikes, and the much smaller nut and short bristles. In general appearance it more nearly approaches to R. gracilenta, *Gray*, but the nut is quite different, and the bristles are not antrorsely hispid as in that species. I learn from Dr. Knieskern, that it grows exclusively on banks of iron ore in the Pine barrens of New Jersey. He distributed it, as new, under the name of R. Grayana, which name being preoccupied by Kunth for the R. Elliottii, *Gr. Mon. Rhynch.*, I dedicate it to the discoverer.

ART. V.—*Observations on the Whirlpool, and on the Rapids, below the Falls of Niagara; designed by illustrations to account for the origin of both;* by R. BAKEWELL, New Haven.

ON my return to England soon after visiting the Falls of Niagara in the year 1829, I published in Loudon's Magazine a short memoir illustrated by drawings, exhibiting the physical structure of the country along the river Niagara, with special reference to the retrograde movement of the falls; in the course of my remarks I endeavored to prove from the conformation of the strata, and the erosive action of water, that the falls were once at Queenston. During the six days that I remained there, I made several sketches of the falls and the surrounding scenery, little expecting at the time that I should ever see the cataract again. I returned to America to reside in the summer of 1830, and in the autumn of 1846, I spent eight days at Niagara, taking with me the sketches which I had made seventeen years before. After a lapse of so many years, I was sensibly impressed with the change, which had taken place, particularly in the Canada fall. The waters had receded from the American side of the Horse-shoe fall towards the centre; parts of the precipice were bare which in 1827 were entirely hid by the descending flood. The water which then

flowed over these projecting bare rocks, in descending, spread out into magnificent festoons. The beautiful feature which I formerly saw has disappeared. To this it may be said, that the waters of Lake Erie were unusually low in 1846, and this may account for the retreat. But I would reply, that no diminution was indicated by the banks of the river. I was told in 1829, by one who had resided there forty years, that a difference of level was perceptible only when a strong southwest wind sweeps over the wide expanse of Lake Erie, driving its waters into the mouth of the river. Not having made a very careful outline of the edge of the American fall, I am not prepared to say, whether any material change had taken place, with the exception of its being apparently more broken in the centre, where the cutting process appears to go on with great activity. It is stated by residents there, that a considerable alteration had taken place, from the falling of masses of limestone rock from the middle of the cataract. That a constant change is in progress no one can doubt who carefully examines for himself as he wanders over this wonderful scene. I was particularly impressed with its magnificence while making a drawing of what is called the cave, situated half a mile below the ferry on the American side. This cave or ledge of bare rock, has just the appearance that the rocks over which the American falls are now precipitated, would present, if the *waters were suddenly withdrawn.* The same broken outline appears in both instances, giving evidence that in each case the most violent action had been in the centre. When the cataract was here, the space between the American fall and the commencement of the 'cave', was in all probability, an island, presenting a similar appearance to what the falls now have. There is still a small stream flowing down the precipice where once a mighty torrent fell.

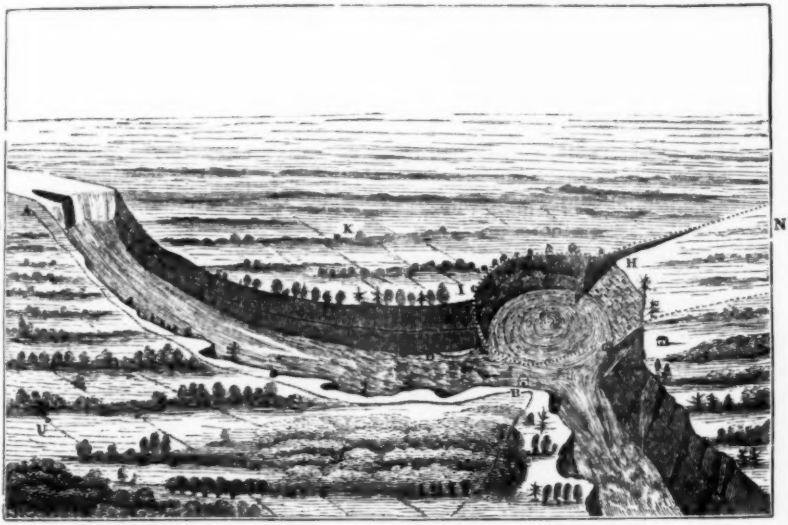
What surprised me much on my second visit, was the comparative stillness in which the mighty work of discharging the surplus waters of so many inland seas down a precipice of one hundred and eighty feet was carried on. In father Hennepin's curiously interesting description of this "vast and prodigious cadence of water," he represents himself or his friends as being so overcome by the noise, that the hands were applied to the ears by way of dampers. The marvel to me is, that they make so little noise. It cannot be denied, however, that the state of the atmosphere and direction of wind, have much to do in regulating the sound produced by the fall of this immense body of water.

After these preliminary remarks, I will now confine myself more particularly to the object for which this communication was undertaken, which was to offer some observations on the whirlpool, as well as on the rapids below the falls, and to assign a probable cause for their existence. If in doing this I should be

able to add any thing to the interest which will ever be felt by those who visit the falls, and its vicinity, my labor will not be altogether in vain.

Fig. 1.

A Birds-eye View, or Map of the Ravine from the Falls of Niagara to the Whirlpool.



K. Canada.—U. United States.—The dotted lines represent the outline of the ancient valley, partly filled with drift, H.—F. Ravine.—C. Whirlpool.—B. Summer-house.—D, E. Quartzose rock seen below the surface of the water.

Having made several visits to the whirlpool, taking sketches from points which I thought most desirable, I found that each visit increased my admiration and wonder. A general idea of its situation may be had by reference to the drawing, fig. 1, giving a birds-eye view of the country from the falls to the whirlpool, a distance of three miles. Perhaps I shall make myself better understood by giving a description of the ravine from A to B. The width of the river at the ferry is about eleven hundred and forty feet. The height of the rocks, one hundred and eighty feet. On the verge of the precipice, a little below the American falls, there is a path which leads directly to the Summer-house, B, situated immediately above the whirlpool; this path continues close to the edge of the precipice. About half a mile down, we come to the 'cave' before alluded to—a bare rock on which nothing grows—a place of deep interest to the traveller as he stands upon this ancient bed of a former lateral torrent.

The river below the falls moves majestically along without a ripple, having the appearance of dark bottle-green marble, varying

at times into blue, with yellowish and greenish veins, the latter due to the foam which seems as if imbedded as it streams down in long wavy lines. This solid representation of water, gave an additional novelty to the scene. About one mile from the falls the sides of the ravine gradually converge, diminishing of course the width of the river. Half a mile still lower,* following along by the edge of the precipice, the stream takes a gentle turn to the left. The water on each side is seen to ripple; then commences a chain of waves preceded by deep furrows, which converge to a point in the middle of the river, indicating not only the rapidity of the current, but also the upheaving of the waters, rising, as has been ascertained by measurement, eleven feet above the level at the sides; after this, it is broken into foam and spray, and dashing on with impetuous fury, pursues its wild career for about a mile, then rushes with the swiftness and violence of an avalanche into a wide circular area of one hundred and twenty acres in extent. Then, suddenly, as by an unseen power, it is calmed down, and in silence sweeps round in eddying circles; these circles glide into curves which swell round this vast amphitheatre in gentle undulations, as if gathering strength for its last conflict through the narrow portal which leads to its oblivion in the waters of Ontario.

While standing on the precipice at the Summer-house, (B, fig. 1,) which overlooks the whirlpool, my attention was particularly directed to the place where the waters enter the whirlpool, where I could distinctly see the rocks projecting for a considerable distance from the Canada side towards the centre of the current, not many feet below the surface of the water, contracting very considerably the space through which the waters apparently escape. The curved line, DE, indicates this projection. There was something impressively grand in the whole scene as contemplated from this point. The drainage of four great lakes covering an area of about 135,000 square miles, escapes at the northern extremity of Lake Erie through a channel, (as stated by Mr. Allen, from measurements by Mr. E. R. Blackwell,) seventeen hundred feet in width, thirty-two feet in depth, running at the rate of six miles an hour, equal to 22,440,000 cubit feet, weighing 701,250 tons, flowing every minute;†—here the whole is confined to a breadth not exceeding two hundred and twenty-five feet! the distance from rock to rock, as I was informed by the proprietor

* I observed a steamboat intended to ply between a landing place, which had been constructed at great expense down the precipice to the water's edge, at the base of the falls, &c.; but on trial, the engine had not power sufficient to contend with the current. It is to be hoped the project will be forever abandoned. In case of accident to the machinery, there is nothing to prevent the destruction of the boat in the rapids.

† Am. Jour. of Sci., Vol. xlvi, p. 71.

of the grounds. The question naturally arises, how is it possible for this immense volume of water to escape through so narrow a defile, and then suddenly to become comparatively sluggish in the whirlpool. On referring to Mr. Lyell's admirable work on America which I had with me, and examining the section of the strata from Niagara to the whirlpool, which Mr. L. had taken from Mr. Hall's geological Report on the Geology of New York, it occurred to me that a satisfactory explanation might be given. The projecting rock under the water is unquestionably the hard quartzose sandstone, and underneath this lies a very thick bed of soft red shale. A short distance before the waters enter the whirlpool, this floor of hard sandstone rock is broken through, and the resistless torrent has made itself a passage underneath this rock, on each side of the ravine, and it is by this excavation that the waters escape. This perhaps will be made more apparent, when explaining in the sequel the supposed origin of the whirlpool.

The section, fig. 2, is principally from Lyell, in which I have introduced the river, whirlpool, and the ancient lateral valley, (H,) filled with drift. In the following remarks, great stress is laid on the relative hardness of the rocks which compose the Niagara group: consisting as it does, of hard limestone, calcareous shale, soft shaly sandstone, and of quartzose sandstone. Had all the strata consisted of solid limestone, as I remarked in the communication before re-

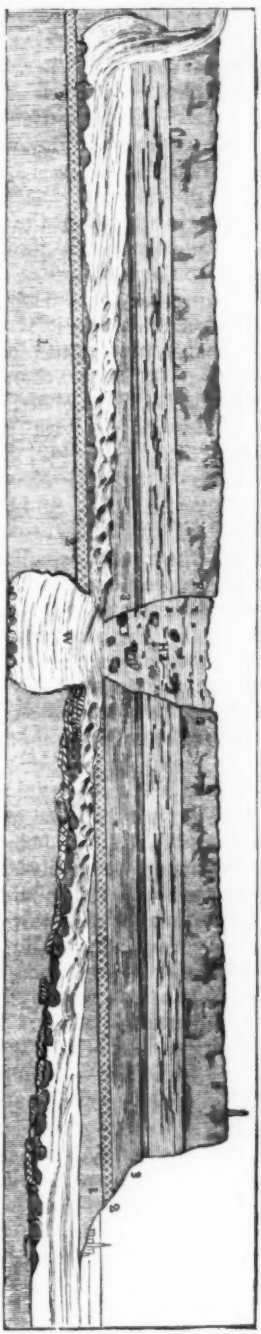


Fig. 2.

A Section of the Strata on the Canada side of the Niagara River, from the Falls to Queenston.

F, G. Compact limestone resting on soft beds of shales.—3. Red shaly sandstone—very friable drift.—2. Quartzose sandstone extremely hard.—1. Thick bed of shale, very soft.—H. Valley filled up with drift, marked H in fig. 1.—W. Whirlpool, which forms the terminus to the deep lateral valley as represented by W in fig. 4, and by the dotted lines, 1, F, G, in fig. 1.

ferred to, 'there is great reason to believe that the erosive action of the water would have been very slow, and many generations might have passed without any sensible change; but the vast mass of waters breaking with inconceivable force on the softer shale which forms the base of the hard rock, the foundation is thus undermined, the harder rocks fall down for want of support,' thus causing the various changes between turbulence and tranquillity which take place in the river in its course from the falls to the outlet at Queenston.

Taking it for granted that the cataract was once at the precipice at Queenston, it will be seen by reference to the section, fig. 2, that, owing to the inclination of the strata, the falls would be considerably higher than they are at present; thus exposing to view several beds of shale, limestones, and sandstones not found at the falls. The lowest (No. 1) is a very thick stratum of friable shaly red sandstone, through which the river ploughs its way. The river at Queenston, as we are informed by Mr. Allen, before referred to, is one hundred and sixty feet in depth. This depth is sufficient to entomb the huge fragments of the harder rocks, as they would gradually fall down by the erosive, undermining process continually going on by the descending flood, without causing any agitation of the surface. It will be seen from the dip of the strata, that as the falls retrograde, the hard quartzose rock would be at the base of the falls, and in time cease to be broken through by the cataract; as the retrocession advanced, the waters would have to flow *over* this hard rock. The superincumbent limestone falling on this hard pavement would cause a great impediment to the escape of the water, which would give rise to the rapids.

From the whirlpool to what is called the Devil's hole, and for a considerable distance below, the river rushes with great impetuosity, when it gradually subsides, and then moves on in silent grandeur towards the lake. On crossing the river at Lewiston, and ascending the hill near Brock's monument, I was agreeably surprised on beholding the singular and furrowed appearance of the ground. It was smooth on the surface, but shaped into knolls and ravines, having the appearance of a mountainous country in miniature—hills and valleys—but without water; and this all excavated out of the hard limestone rock. This appearance gave me satisfactory evidence that the waters of the lakes once rushed over the ground on which I was walking.

The whirlpool as seen on the Canada side of the river, presents many more points of interest than on the American, independently of the curiosity excited by Mr. Lyell's discovery of a deep lateral valley filled with drift, which he traced from the whirlpool to St. David's; Mr. Hall having first suggested the idea that it might be connected with the opening at that place.

Fig. 3.

Sketch of the Whirlpool taken on the Canada side near the ravine which forms part of the lateral valley marked F G, on the map fig. 1.

On the Canada side, more than three-fourths of this magnificent amphitheatre of rock may be explored along the margin of the pool which it incloses. One reason why so few comparatively visit the whirlpool on this side, is the want of enterprise in the individual who owns the land, in not making the descent more practicable. On visiting the place last summer, it was not only very difficult but dangerous to descend, particularly so after rain. Having reached the base of the precipice and scrambled over rocks and through dense masses of roots, decayed branches and foliage of trees, for about the space of two hundred yards, the entanglement suddenly disappears, and a clear open space is left along the margin of the pool, on which it is a great pleasure to rest and admire the sublime scene. The shore is uninterrupted for near two hundred yards; after which it is obstructed as before, by huge fragments of rocks, &c. The foreground of the sketch, fig. 3, from A to B, represents this open space, which also indicates the extent of the base of the cliff of drift lying between the rocks F and G, in figs. 1 and 2. The cliff is less precipitous than the rocks which enclose it; its debris consists of sand with boulders of conglomerate or igneous rocks, and affords easy access to the water's edge.

At the northern extremity of the whirlpool, there is by far the most comprehensive view of the high perpendicular wall of rocks which encloses this deep, dark, circling pool. Here we are brought to the immediate confines of the whirling vortex. On its surface are seen the ruins of a forest, floating round, marking out to the eye the outline of that fatal circle. These yellow logs and trunks, grinding against each other, dip and rise, following on in ceaseless round until they waste away in this their winding sheet. Occasionally, some are thrown out and are borne along in a circuitous route to the rapids which commence at the outlet of the whirlpool; a few find a resting place on the beach, where they present many very grotesque forms, some resembling the boomareng of the New Hollander, others cimiters, rolling-pins, and the like.

The sketch, fig. 3, was taken at the northern extremity near the gorge, marked F, fig. 1. In going up this narrow gorge, through which a small stream flows, I was very much interested in noticing that the high perpendicular rocks which form part of the Niagara group on my left, presented the same wall-like appearance as in the ravine through which the river flows, from the falls to Queenston. Fragments of limestone rock which once crowned the summit of the precipice, lay in confusion at its base. On my right rose the steep cliff of drift, H, with its motley group of boulders extending from F to G. As I was exploring this wild picturesque gorge, formed at the western extremity of the lateral valley by the descending rains washing away the sand

into the whirlpool, I was led to think that in all probability, there was a time when the cataract thundered through this channel, now nearly filled with drift, and its waters emptied into the lake or sea, through the opening at St. David's. That this assertion may not appear altogether visionary, I would state that it is an ascertained fact, that this ancient valley extends from the whirlpool to St. David's, about six miles from Queenston, as was first suggested by Mr. Hall to Mr. Lyell, when the latter having called Mr. Hall's attention to this bed of drift at the whirlpool. "Ascending," says Mr. Lyell, "the steep bank formed of these materials, we soon reach the general level of the table land and pass over it for two miles before we begin to enter the depression, which deepening gradually, carries us down to St. David's. This valley is entirely excavated in the boulder formation, and we may infer that the latter maintains its full depth between St. David's and the whirlpool, from sections obtained in sinking a well in the intervening township of Stamford, where a great thickness of drift was passed through."*

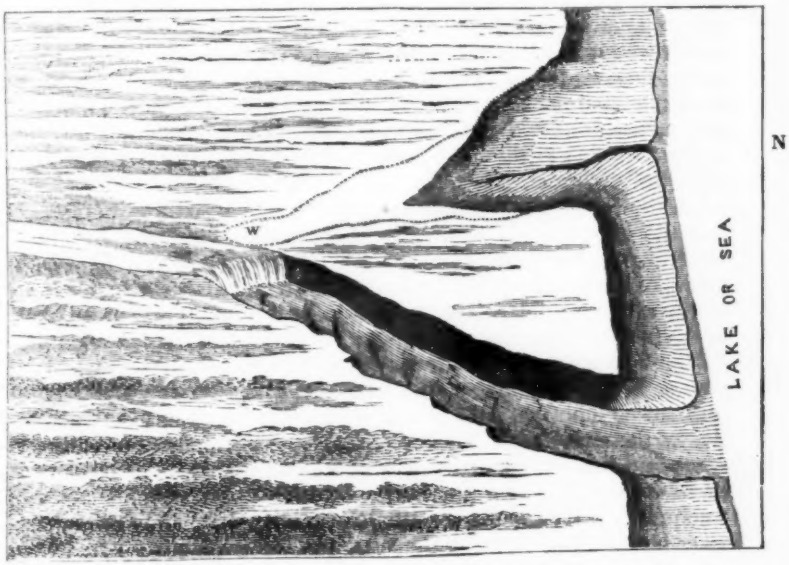
It is perhaps worthy of remark that the direction of this valley from the falls to St. David's, does not materially differ from a straight line. The width of this valley, at the whirlpool, (FG, fig. 1,) which is deserving of particular attention, Mr. Lyell gives at about one hundred and seventy yards. Now this width, whether more or less than one hundred and seventy yards, agrees so nearly with the width of the ravine at the entrance into the whirlpool, IB, that it is difficult to resist the conclusion that they had both one origin, but at periods of time immeasurably remote from each other. The continuous appearance now presented is accidental. The origin of this valley and its termination at the whirlpool may, I think, be explained on the supposition that ages anterior to the commencement of the ravine at Queenston, this valley or channel was hewn out by the floods which drained the inland lakes or sea. The width of the valley at St. David's, which is about two miles, militates nothing against the assumption that the waters once rushed over the precipice at St. David's. It is reasonable to infer that its volume was immeasurably greater than at present, and that in process of time the valley would contract, as the waters were concentrated and were brought to act with greater energy on a given point on the various strata of hard and soft rocks; this increased erosive action of the waters would go on until the cataract would finally assume a wall-like appearance as is now seen at the falls. This process appears to have gone on from the time when the river first fell over the precipice at Queenston, and thus the falls have continued to advance on their retrograde journey south. This I think is very evident from what

* Lyell's America, Vol. ii.

is now seen on the sides of the declivity near Brock's monument. The smooth, scooped out appearance in the solid limestone rock, as before alluded to, indicates that long before the waters were concentrated at the ravine at Queenston, they were for ages sweeping over the precipice on each side of the present opening. When the falls had retrograded as far as is represented by the dotted lines in fig. 4, their further progress was arrested by physical changes constantly but slowly going on, according to Mr. Lyell, which have so materially changed the surface and condition

Fig. 4.

The supposed situation of the Falls when near what is now called the Whirlpool.



The dotted lines mark the deep lateral valley filled with drift, for a considerable distance towards the Lake.

of the globe. This was chiefly the submergence of the whole table-land, which, Mr. Lyell, in his work before referred to, says, caused the valley to be filled up and also covered the table-land itself with drift, which in some places is three hundred feet deep. After a long interval of time the country was again elevated, or the sea retired, exposing the precipice over which the waters would rush. But their direction, from the great inequalities of the surface arising from the accumulations of drift, might be changed, and instead of continuing to plough out for itself a passage in its former channel, might finally be concentrated about

the precipice at Queenston, and there commence anew its great work of retrocession. It will be seen by reference to fig. 4, that the ravine at Queenston and onward, to the whirlpool, is not parallel to the lateral valley, (represented by dotted lines,) but makes an angle, the apex of which is the head of the valley. When the falls advance to the dotted lines, W, which mark the boundary of this valley of drift, and had broken and cut its way through the hard limestones, &c., into this soft and very thick bed, a violent and rapid excavation would go on by the mighty force exerted from the falling cataract on the soft material, most of which would be carried away in the form of mud. As this drift descended far into the soft shale below the quarztose rock, it is highly probable that it was cleared out, forming a vast *circular* pit, and it is this which caused the gyratory motion of the water. Fig. 2, W, gives a representation of this pit. Had the falls retrograded a few yards east of the point, W, which represents the head of the valley, there would not have been what is now called the whirlpool; for then it would not have entered the soft bed of drift at the head of the valley, out of which I believe the whirlpool was formed.

On the falls retreating from the whirlpool, it will be noticed, that the hard quartzose rock, 2, fig. 2, would form the base of the falls, and then an obstruction would be made to the free egress of the water; the hard rocks would then fall *on* this pavement, which would greatly increase the obstruction and give rise to the rapids, and this would continue as the falls receded, until by the indication of the strata, this hard rock would by degrees sink so low as to allow a depth sufficient for the waters to flow without commotion. This will be evident by an inspection of fig. 2, the stratum, 3, being soft shale. The inclination of the strata and the soft character of the rocks through which the river flows at the falls, are the causes of that apparently miraculous tranquillity which is observed to take place immediately after the river has plunged down the precipice. This sudden repose surprised me more than the falls themselves.

ART. VI.—*On certain Improvements in the Construction and Supply of the Hydro-oxygen Blowpipe, by which Rhodium, Iridium, or the Osmiuret of Iridium, also Platinum in the large way, have been fused;* by ROBERT HARE, M.D., Professor of Chemistry in the University of Pennsylvania. (Communicated by the Author.)

HAVING observed while I was a pupil of my predecessor, Dr. Woodhouse, in the year 1801, that a jet of hydrogen when inflamed in atmospheric air, of which only one-fifth is oxygen, produced a heat of pre-eminent intensity, I was led to infer that in combining with pure oxygen, the gas in question ought to produce a temperature at least five times as great. This led to the contrivance of two modes of producing a jet consisting of a mixture of hydrogen with oxygen. Agreeably to one mode, the gaseous currents meeting like the branches of a river, were made analogously to form a common stream. This object was accomplished by means of perforations drilled in a conical frustum of pure silver, so as to converge until met by another shorter perforation, commencing at the opposite surface, and so extended as to join them at the point of their meeting. The other mode was that of causing one tube to be within another, so as to be concentric; the outer tube being a little the longer of the two, the latter being employed for hydrogen, the former for oxygen.

In the year 1814, this last mentioned mode was improved, so as to have the means of securing, by adjusting screws, the concentricity of the tubes, and varying the distance of the orifice of efflux of the inner tube from that of the other.

The constructions employed in 1801, were described and published in a pamphlet, and afterwards republished in Tilloch's Philosophical Magazine, Vol. xiv, and in Annales de Chimie, Vol. xlv. At the same time an account was given of the fusion of pure lime and magnesia, and of the fusion of platinum. Subsequently in a paper published in the Transactions of the American Philosophical Society, it was mentioned that I had volatilized platinum.

About the year 1811, Professor Silliman, in a memoir read before the Connecticut Academy of Sciences, gave an account of a series of experiments, in which the experiments which I had performed were repeated, and many additional fusions made. I had adverted to the intensity of the light produced during the exposure of lime to the flame. Alluding to the heat and light, my words were, "the eyes could not sustain the one, nor the most refractory substances resist the other." The intensity of the light was still more insisted upon by Silliman.

My experiments were also repeated by Mr. Rubens Peale, during many successive years, at the Philadelphia Museum, for the amusement of visitors.

About the year 1813–14, it was ascertained, at the laboratory of Dr. Parrish, that a bladder being supplied with a mixture of hydrogen and oxygen, in due proportion, and punctured by a pin, while subjected to compression, on igniting the resulting jet, the gas within the bladder did not explode. Of course a burning jet of flame thus created, was found competent to produce, while it lasted, the same effect as when otherwise generated by the same gaseous mixture.

Soon after this result was obtained, Sir Humphrey Davy discovered, that if a lamp flame be completely surrounded by a gauze of fine wire, it may be introduced into an inflammable gaseous mixture without causing it to explode. This was ascribed to the refrigerating influence of the metal, keeping the gaseous mixture below the temperature requisite for inflammation. Hence it was inferred, that if a mixture of hydrogen and oxygen, while condensed within a suitable receiver, were allowed to escape through a capillary metallic tube, so as to form a jet, this might be made to burn without communicating ignition to the portion remaining in the receiver.

By means of an apparatus contrived agreeably to this idea, Dr. Clark of Cambridge, England, repeated the experiments, made many years before by Silliman and myself, without any other reference to ours, than such as was of a nature to do injustice. An exposition of the invalidity of Dr. Clark's pretensions to originality was made in Silliman's Journal for 1820, vol. ii, and in Tilloch's Philosophical Magazine, for 1821, vol. lvii.

The light produced by the hydro-oxygen flame with lime having been observed by Lieutenant Drummond, of the British navy, was ingeniously proposed by him, as the means of illumination in light-houses, and in consequence, has been subsequently used as a substitute for the solar rays, in an instrument known as the hydro-oxygen microscope, which is a modification of that which has been called the solar microscope. The name of Drummond light has consequently been given to a mode of illuation, which I originally produced as above stated.

The instrument which was used by Professor Silliman and by Rubens Peale, was that above described as having two perforations meeting in one. In this form it was, I believe, employed by Dr. Hope, of Edinburgh, and Dr. Thompson of Glasgow, who both treated it as my contrivance, anteriorly to the publication of Dr. Clark's memoir.

The other form, consisting of two concentric pipes, was modified by a Mr. Maungham, with the view of producing a lime light for the microscope above alluded to. When I saw Mr.

Maungham at the Adelaide gallery in 1836, he treated this instrument as mine, in another form. I was surprised afterwards to learn that he had obtained a premium for this modification from the British Society for the Encouragement of Arts, without any allusion to the original inventor.

After my return from Europe in 1836, I was very much in want of a piece of platinum of a certain weight, while many more scraps than were adequate to form such a piece were in my possession. This induced new efforts to extend the power of my blowpipe; and after many experiments, I succeeded so as to fuse twenty-eight ounces of platinum into one mass.

Although small lumps of platinum had been fused by many operators, with the hydro-oxygen blowpipe, as well as myself, it had not, up to the year 1837, been found sufficiently competent to enable artists to resort to this process. I am informed by Mr. Saxton, that some efforts which were made while he was in London were so little successful, that the project was abandoned. There was an impression that the metal was rendered less malleable when fused upon charcoal, as in the experiments alluded to. This is contradicted by my experiments, agreeably to which fused platinum is as malleable as the best specimens obtained by the Wollaston process, and is less liable to flake. The celebrated Dr. Ure, on seeing the platinum in the form of wire, of leaf, and plate, said that there was no one in Europe who could fuse platinum in such masses. He also alledged that it had been found so difficult to weld platinum, that no resort was had to that process. In this I concur, having had the welding tried by a skillful smith, both with a forge heat, and with a heat given by the hydro-oxygen blowpipe. An incorporation of two ingots was effected on their being hammered together, when heated nearly to fusion; but on hammering the resulting mass cold, a separation took place along the joint by which the ingots were united.

The difficulty seems to arise from the rapidity with which the platinum becomes refrigerated. It seems to have a less capacity for heat than iron, and, not burning in the air as iron does, has not the benefit of the heat acquired by iron from its own combustion with atmospheric oxygen.

Lately, by means of the instrument and process which it is my object here to describe, I have been enabled to obtain malleable platinum directly from the ore, by the continued application of the flame. From some specimens of platinum I have procured as much as ninety per cent. of malleable metal. The malleability is not inferior to that of the best specimens obtained by reducing it to the state of sponge, through the agency of aqua-regia and sal-ammoniac. There is, however, a greater liability to tarnish, arising, probably, from the presence of a minute portion of palladium.

Of the fusion of iridium and rhodium, I have already given an account in the Bulletin of the American Philosophical Society, which was subsequently embodied in an article in this Journal for October last, 1846.*

It remains now to give an account of the apparatus employed in the fusion of platina on a large scale.

Fig. 1 represents the association of fifteen jet pipes of platinum with one large pipe, B, D, at their upper ends, so that their bores communicate, by means of an appropriate brass casting, with that of the large pipe, the joints secured by hard solder. Their lower extremities are made to protrude about half an inch from a box, A, of cast brass, their junctures, with the appropriate perforations severally made for them, being secured by silver solder. They come out obliquely in a line along one corner of the box, an interval of about a quarter of an inch alternating with each orifice. By means of flanges, the brass box is secured to a conical frustum of copper, fig. 2, so as to form the bottom thereof, while the pipe, extending above the copper case, is screwed to a hollow cylinder of brass, A, fig. 3, provided with two nozzles and gallows screws, *g*, *g*, for the attachment of appropriate hollow knobs, to which pipes are soldered, proceeding from the reservoirs of oxygen and hydrogen. Cocks are interposed by which to regulate the emission of the gases in due proportion.

In connecting the pipes conveying the gases with the brass cylinder, A, fig. 3, care should be taken to attach that conveying oxygen to the upper nozzle, while the other, conveying hydrogen, should be attached to the lower nozzle; since, by these means their great difference in density tends to promote admixture, which, evidently, it must be advantageous to effect.

The object of surrounding the jet pipes with water, by means of the copper box,† is to secure them against being heated to such a degree as to cause the flame to retrocede and burn within them, so as finally to explode within the cylinder, A, *g*, *g*, fig. 3. It is preferable to add ice or snow to the water, in order to prevent undue heat.

Fig. 4 represents a movable platform, A, of cast iron, wholly supported upon the point of the iron lever, D, B, which is curved towards the extremity under the platform, so as to point upwards, and to enter a small central conical cavity made for its

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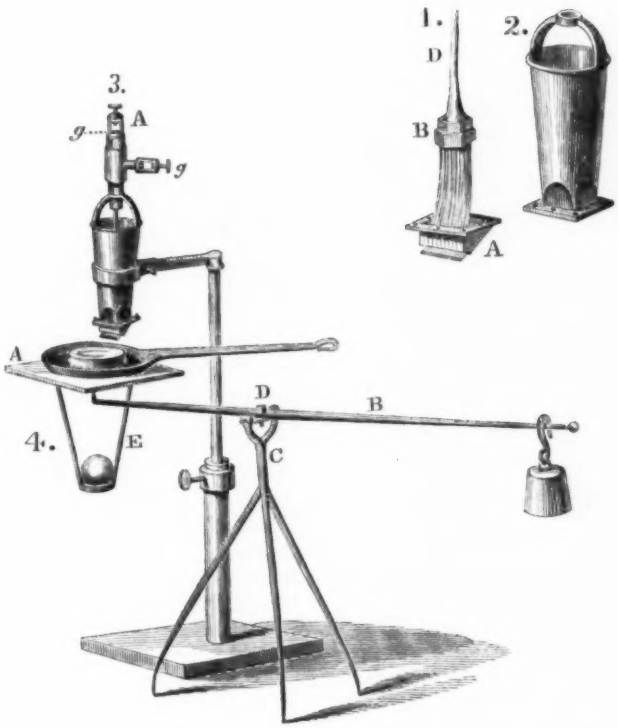
* Since published in the Revue Scientifique at Paris.

† Since the engraving was made, I have preferred to use water-tight boxes, with gallows screws and nozzles, situated one near the bottom on one side, the other on the opposite side near the top. By means of the lower nozzle, a pipe is attached, communicating with a head of cold water, the other being so situated as to carry the water into a waste pipe, or large tub; a circulation may be kept up during the whole time that the operation is going on.

As a support, a brick kaolin is used, having an oblong ellipsoidal depression on the upper face for the reception of the metal to be fused.


1.
D
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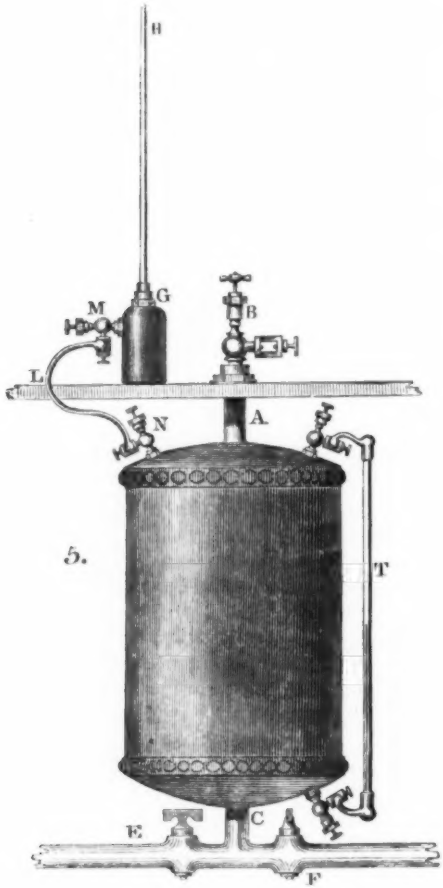


5.

reception. The lever is supported by a universal joint upon the fulcrum, C, so that by means of a sliding weight at one end, the platform and its appurtenances are counterpoised at the other. The platform is kept in a horizontal position by the cannon ball, supported in a sort of iron stirrup terminating in a ring, in which the ball is placed. Upon the platform is situated an iron pan with a handle, holding the brick, on a cavity in which as already mentioned, the metal is supported. The apparatus being duly prepared, and connected with the supply pipes, the hydrogen is first allowed to escape, and then the oxygen, until the ignition has attained apparently a maximum. The accomplishment of this object may, of course, require the adjustment of either cock several times, especially where there is any decline in the pressure either of the one or the other gas in its appropriate reservoir.

By means of the handles of the lever and of the pan, the operator is enabled to bring the metal into the position most favorable for the influence of the heat, while his hands and face are sufficiently remote to render the process supportable. In fusing any quantity, not being more than four ounces, the platform may be dispensed with, the handle of the pan being held in one hand of the operator, while by the other, the cocks may be adjusted.

When the blowpipe of fifteen jets, or any larger, may be employed, and the platform is necessarily resorted to, the cocks must be adjusted by an assistant.

Fig. 5 represents a cask made of boiler iron, three-sixteenths of an inch thick, so as to resist an enormous pressure. The joints are secured by riveting, as in constructing high pressure boilers.

This cask communicates with the hydrant pipes, so called, by which our city is supplied with water, of which the pressure varies from a half to more than two atmospheres, say from seven to thirty pounds per square inch, according to the number and bore of the cocks from which the water may be flowing at the time, for the consumption of the community. Hence, experiments, while using this head, are best made towards bed-time, or between that time and sunrise. The vessel is filled with water by opening a cock, F, on one side of the pipe, C, and allowing the air to escape through the valve-cock, B. Being thus supplied, the cock, F, closed, and a communication with a bell glass, into which oxygen is proceeding from a generating apparatus, being made by means of a flexible leaden tube, on opening the valve cock, B, and the cock, E, the water will run out, and be replaced by gas from the bell. This process being continued till the iron cask is sufficiently supplied with gas, the cock, E, must be shut. Whenever the gas is wanted for the supply of the blowpipe, it is only necessary to establish a communication between the valve-cock, B, and the upper gallows screw, fig. 3, of the cylinder, A, and to open the cock, F, so as to admit the water to press upon

the gas, the efflux being regulated by B, or preferable by a cock of the ordinary construction, one of which kind should be interposed at a convenient position between the valve-cock, B, and cylinder, A.

T, represents a glass tube, which, by due communication with the interior, shews the height of the water, and consequently the quantity of gas in the vessel.

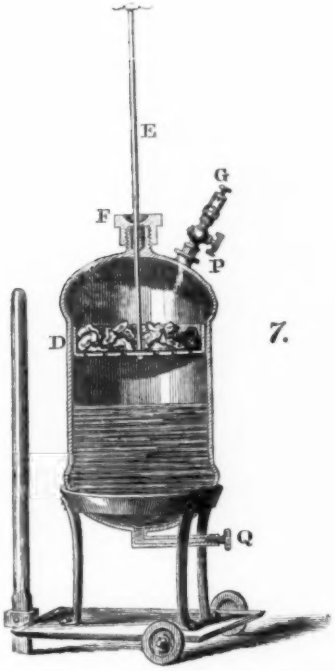
G, H, represents a gauging apparatus, consisting of a cast iron flask, of about a half a pint in content, and a glass tube of about a quarter of an inch in bore, which should be at least five feet in height. The tube is secured air-tight into the neck of the flask, so as to reach nearly to the bottom within. The flask is nearly full of mercury. Under these circumstances, when a communication is made, by a leaden pipe between the cavity of the flask and that of the reservoir, an equilibrium of presure resulting, the extent of the pressure is indicated by the rise of the mercury in the tube.

In order to generate hydrogen for the supply of a reservoir like that represented by the preceding figure, I have employed the vessel represented by fig. 7. This vessel, by means of a suitable aperture, susceptible of being closed by a screw plug, is half filled with diluted sulphuric acid. Being furnished with a tray of sheet coper, D, punctured like a coal sieve, and supported by a copper sliding rod, E, strips of zinc are introduced in quantity equal to the capacity of the tray. The sliding rod passes through a stuffing-box, F, at top of the reservoir, so that the operator may, by lowering or raising the tray, regulate or suspend the reaction between the zinc and its solvent, accordingly as the supply of hydrogen is to be produced, suspended, increased, or diminished.

The communication with the reservoir is open and regulated by means of a cock, P, furnished with a gallows screw, G, for the attachment of a leaden pipe, as above described, in the process for supplying the reservoir with oxygen.

Another apparatus for producing a supply of hydrogen, is represented in fig. 6. It consists of two similar vessels of boiler iron, each capable of holding forty gallons. They are lined internally with copper, being situated upon a wooden frame, so that the bottom of one is two-thirds as high as the top of the other. The upper portions of these vessels communicate by a leaden pipe, B, of about half an inch bore, furnished with a cock, while the lower portions communicate by another leaden pipe of a bore of one and a half inches.

The upper vessel is surmounted by a globular copper vessel, of about twelve inches in diameter, which, from its construction, renders it possible to introduce an additional supply of concentrated acid, while the apparatus is in operation, without reducing the pressure within the reservoir, by permitting the excess above the pressure of the atmosphere to escape. This object is accomplished as follows:—



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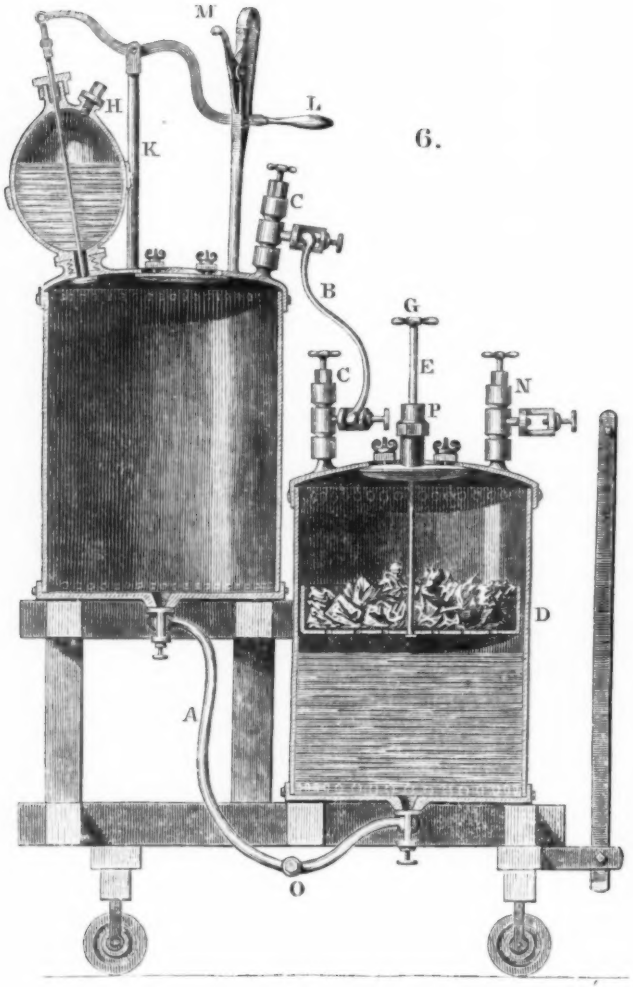


6.

The valve at the end of the rod, attached to the lever, L, being kept shut by the catch, M, the screw plug, H, removed, the acid is introduced through the aperture thus opened. In the next place, the plug being replaced, and the valve depressed by means of the lever and rod, so as no longer to close the opening, which it had occupied, the acid descends from the chamber into the cavity of the vessel beneath it. The valve is of course restored to its previous position as soon as the acid has effected its descent.

The lowermost vessel is furnished with a perforated copper tray, supported by a copper sliding rod, in a way quite analogous to that already described in the case of the copper reservoir. It is also supplied with zinc and its solvent in like manner, being made half full of the diluted sulphuric acid. Of course, on contact being produced between the zinc and its solvent, the generation of hydrogen will take place. So long as the communication between the upper portions of the two vessels is open, the gas will extend itself into both, occupying the whole of the upper vessel, and that half of the lower one which is unoccupied by the liquid. But if, in this way, the pressure reaches to two atmospheres, as indicated by the gauge,* on shutting the communication through the pipe, B, the pressure in the inferior vessel will augment, that in the superior vessel remaining as before, but the liquid will consequently begin to pass out of the inferior vessel through the pipe A, and thus may lessen the contact between the acid and zinc, and finally suspend it altogether. Meanwhile the gas in the upper vessel being condensed to nearly half its previous bulk, the pressure will be nearly four atmospheres. It will, in fact, always be nearly double that which existed before the pipe, B, was closed.

In order that nearly the whole of the acid shall be expelled from the inferior vessel, the tray must be depressed till it touches the bottom of that vessel.

The pressure being four atmospheres at commencement, as soon as, by means of a pipe attached to the valve-cock, N, an escape of gas is allowed, the acid is forced again upon the zinc, and thus prevents a decline of pressure to any extent sufficient to interfere with the process.

The gases may be used from a receiver in which they exist, in due proportion, safely by the following means:—

Two safety tubes are to be made, not by Hemming's process exactly, but as follows:

A copper tube, silver soldered, of which the metal is about the eighth of an inch in thickness, is stuffed with the finest copper wire, great care being taken to have the filaments straight and

* I have used for a gauge an instrument like G, fig. 5, the tube being about two feet in length, and sealed at the upper end.

parallel. The tube is then to be subjected to the wire-drawing apparatus, so as to compress the tube on its contents until the draught becomes so hard, as that it cannot be pushed farther without annealing. The stuffed tube thus made is to be cut into segments, in lengths about equal to the diameter, by a fine saw. The surfaces of the sections are to be filed gently with a smooth file. By these means, they appear to the naked eye like the superficies of a solid metallic cylinder. Brass caps being fitted on these sections, they are to be interposed by soldering, at the distance of a foot or more, into the pipe for supplying the jet. Under these circumstances, the posterior section becoming hot, may allow the flame to retrocede; but the anterior section being beyond the reach of any possible combustion, and remaining cold, will not allow of the retrocession; and as soon as the flame passes the first section, the operator, being warned, will, of course, close the cock, and subject the posterior section to refrigeration before proceeding again.

But this plan of operating may be rendered still more secure by interposing a mercury bottle, or other suitable iron vessel, half full of oil of turpentine, between the reservoir and safety tubes, as in the arrangement of a Woulfe's bottle. A leaden pipe proceeding from the reservoir is, by a gallows screw, attached to an iron tube which descends into the bottle, so as that its orifice may be near the bottom. The leaden pipe communicating through the safety tubes with the jet-pipe, is attached to the neck of the bottle. Thus the gaseous mixture has to bubble through the oil of turpentine in order to proceed through the safety tubes to the jet-pipe. If, while this process is going on, the flame should, by retrocession, reach the cavity of the bottle, exploding in contact with the turpentine, a compound is formed, which is, *per se*, inexplosive from the excess of carbonaceous matter. Meanwhile the shock, acting on the surface of the oil, drives it into the bore of the iron tube, and thus, both by its chemical and mechanical influence, renders it utterly impossible that the flame should reach the cavity of the reservoir.

Apparatus for the Fusion of Iridium or Rhodium or masses of Platinum less than five ounces in weight.

For the fusion of either Iridium or Rhodium or masses of Platinum not exceeding the weight of half an ounce, an instrument with three jets has been employed, the bore of each jet pipe being such as not to admit a wire larger than the $\frac{1}{32}$ of an inch in diameter. The flame produced by these means was quite sufficient to envelope the mass to which it was applied.

In fusing any lumps or congeries of platinum, not exceeding five ounces, an instrument has been used capable of giving seven jets of gas, issuing of course, from as many pipes. Of these

pipes, six protrude through the brass casting forming the bottom of the copper case constituting the refrigerator, so as to be equidistant from each other upon a circumference of three-fourths of an inch in diameter, the seventh protruding from the centre. The bores of these jets are such as not to admit a wire larger than $\frac{1}{32}$ of an inch in thickness. Those of the larger instruments represented by the accompanying engravings were such as to admit wires of $\frac{1}{24}$th of an inch in thickness.

The jet-pipes may be made by the following process:—A thin strip of sheet metal, somewhat wider than the length of the circumference required in the proposed pipe, after being roughly turned about a wire so as to form an imperfect tube, is drawn through several suitable holes in a steel plate, as in the wire-drawer's process. Under this treatment the strip becomes converted into a hollow wire; the edges of the strip being brought into contact reciprocally, so as to leave only an almost imperceptible crevice. Having drawn one strip of platina in this way, another strip sufficiently wide nearly to enclose it, is to be drawn over that first drawn, care being taken to have the crevices left at the meeting of the edges on contrary sides. The compound hollow wire or tube thus fabricated, is finally to be drawn upon a steel wire of the diameter of the requisite bore.

The following method of making jet-pipes, though more difficult, is preferable; as there is less liability of the water of the refrigerator leaking into the bore.

Select a very sound and malleable cylinder of platina, of about three-eighths of an inch in thickness, perforate it by drilling in a lathe, so that the perforation may be concentric with the axis. A drill between $\frac{1}{16}$th and $\frac{1}{8}$th of an inch in diameter may be employed. In the next place the cylinder may be elongated by the wire-drawing process, until the proper reduction of metallic thickness is effected, the diameter of the bore being prevented from undergoing an undue diminution, by the timely introduction of a steel wire.

Of course, the metal must be annealed as often as it hardens, by drawing. For this purpose, a much higher temperature is necessary in the case of platinum, than in that of either copper, silver, or gold.

The annealing is best performed by the hydro-oxygen flame. If charcoal be used, the greatest care must be taken to have the fireplace clean.

Agreeably to a trial made last spring, palladium may be used as a solder for platinum; and as it is nearly as difficult to fuse as this metal, it is of course, for that purpose, preferable to gold where great heat is to be resisted. No doubt, by employing palladium to solder the exterior juncture of the double drawn tubes above mentioned, they might answer as well nearly as when constructed of solid platinum.

ART. VII.—*Description of Two New Species of Fossil Footmarks found in Massachusetts and Connecticut, or, of the Animals that made them;* by REV. EDWARD HITCHCOCK, President of Amherst College, and Professor of Natural Theology and Geology.

I HAVE long wished to describe several new and peculiar fossil footmarks which have been brought to light in the sandstone of the Connecticut Valley in Massachusetts and Connecticut. But a constant pressure of more important duties has delayed the work, not months merely, but years. I have determined, however, to begin it; hoping that time and health may allow me to prosecute the descriptions in future numbers of the American Journal of Science. For the present I content myself with describing two species; one of them, if I rightly understand it, of most extraordinary dimensions and character.

Before the Association of American Geologists and Naturalists, at their meeting in New Haven, in 1845, I communicated a paper, in which, instead of naming the tracks, as I had formerly done, I attempted to name the animals that made them. That paper I have never found time to get ready for the press; though a list of names was given in the Proceedings of that Society. I am more and more satisfied that this principle, suggested to me by my friend, Mr. James D. Dana, is the true one by which these singular relics should be described.

I have been surprised, however, to learn that some object to giving scientific names, either to these footmarks, or to the animals that impressed them; because they think the characters by which they must be described too indefinite for distinguishing species, or even genera. My reasons for a contrary opinion are briefly as follows.

1. The existence of these tracks demonstrates the existence of certain animals that made them during the triassic period. 2. The facts well known concerning organic remains, render it almost certain, that these animals have never been described, either in the living or fossil fauna of any country. 3. All who have seen a good collection of these tracks, will be satisfied that they were made by several species of animals. Now this conviction must result from some diversity of character, which we witness in these footmarks. And if that diversity could produce such a conviction, it can be expressed in words; and thus the different species, at least many of them, be distinguished from one another. If they cannot thus be distinguished, then they must be regarded as only varieties of the same species. But no comparative anatomist will admit this to be possible. 4. Comparative anatomy teaches us that some of the surest and most constant characters by which animals are distinguished, are derived

from their feet. This is eminently true of birds. "Indeed," says Duméril, "it is by the form and the length of the feet, and the disposition of the toes, that birds are divided into six orders," &c.* 5. Living animals could to a great extent be divided correctly into families, genera, and species, by their tracks. 6. If no fossil animal is to be named until we obtain a complete description of it, then a large part of those already named, should be stricken from the list of organic remains, since only fragments of their skeletons have been found; and we have the authority of Cuvier for saying, that sometimes even the whole skeleton is insufficient to distinguish species from species. "The difference," he remarks, "between two species is sometimes entirely inappreciable from the skeleton. Even the genera cannot always be distinguished by osteological characters."† My conviction is, that not a few fossil animals have been described from characters much more uncertain than those derived from well preserved tracks. 7. We have the highest authority for naming animals from their tracks alone. This was done by Professor Kaup, in the case of the *Chirotherium;* and by Professor Owen, in the case of the *Testudo Duncani;* the only evidence of whose existence is the tracks on the sandstone of Scotland.‡ 8. Convenience in writing or conversing about different kinds of these relics, demands that scientific names should be attached, either to the tracks or the animals that made them. In making attempts to describe them without names, I have sometimes been reminded of the *house that Jack built*, in an old nursery story: Ex gr., "this is the dog that worried the cat, that killed the rat, that ate the malt, that lay in the house that Jack built."

Upon the whole, I cannot see why it is not as desirable, and as consonant to the laws of zoology and comparative anatomy, to derive the name of an extinct animal from its tracks, as from a fragment of a skeleton. Admit that in most cases there may be more danger of mistake in the former than in the latter instance: yet in the first case there is almost every possible degree of uncertainty as to the exact place which the animal ought to occupy. But if well assured of its former existence, why should it not have a name assigned it, among the preadamite inhabitants of the earth, according to the rules of nomenclature derived from zoology and comparative anatomy? So far as these sciences will justify distinctions, and no farther, do I contend for the erection of genera and species. In the present instance, I have so constructed the generic and specific names that they will hold good, though future researches should prove the animals to have been very different in nature from what we now suppose. Fur-

* Elemens des Sciences Naturelles, Tome ii, p. 258, fourth edition.
† Ossemens Fossiles, Tome troisième, p. 524, third edition.
‡ Rep. of Brit. Assoc. for Advancement of Science, for 1841, p. 160.

ther reflection and new discoveries have led me to alter somewhat the names which I presented to the Geological Association. But as I offered at that time no descriptions, I suppose such changes are lawful, according to the rules of zoological nomenclature.

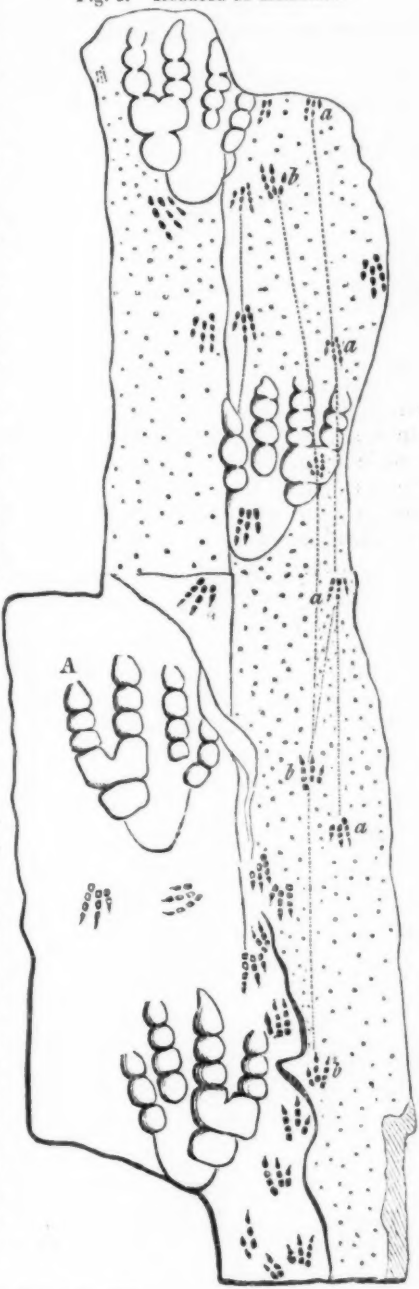
My present object, however, is not to present a complete view of this subject, but only to describe two new species recently discovered in South Hadley. They were brought to light by Pliny Moody, Esq., the same individual, who, about forty-six years ago, discovered near the same spot, the first specimen of footmarks ever noticed as an object of interest in the valley of the Connecticut. That specimen, described and figured in my final Report on the Geology of Massachusetts, plate 48, fig. 55, and now in my cabinet, was turned up by Mr. Moody, then a boy, while ploughing upon his father's farm, and recognized as a row of tracks made by a bird. While he was absent at college, it passed into the hands of Dr. Dwight, of South Hadley. Yet now, after the lapse of nearly half a century, Mr. Moody has found, within ten rods of his house, perhaps the largest and most extraordinary track yet brought to light in this valley. It is but an act of justice, therefore, it seems to me, to affix his name to this most remarkable species, which would have been destroyed by the quarryman had he not rescued it. The slab containing it, is, indeed, considerably mutilated, and only one very distinct track remains. But three others of the same animal are obvious, and enable me to give its characters with considerable confidence. This interesting slab is about ten feet long, six or eight inches thick, and weighs more than half a ton. It is broken open lengthwise, as shown in the drawing, fig. 1: and some smaller fragments are broken off, some of which are lost. Mr. Moody having allowed me to deposit this slab in the Cabinet of Amherst College, I have brought the fragments together, and am gratified to find so much remaining. Besides the large tracks, several rows of smaller species are exhibited almost without any loss. Of the large tracks, four remain. The second (A, fig. 1,) is the most perfect, being deficient in nothing but the extremities of the two middle toes, and a confusion at the end of the shortest lateral toe.* So peculiar is the shape of this track, and so different its phalangeal impressions from those of the feet of any living animal with which I am acquainted, that I should hardly have dared to describe it from a single specimen, had I not found its essential features exhibited in the other tracks. Some of these are badly broken, and others are indistinct, owing apparently to the peculiar state of the mud when they were made. Yet enough remains to identify them with the most perfect one just described. It is clear, also, that they were

* Pres. Hitchcock sent for this Journal an outline sketch of this remarkable track, of full size, (twenty inches in length,) which from the magnitude of the plate required for it, is not inserted.

made by the right and left feet of the animal: and hence I was forced, contrary to my first impressions, to regard the animal as a biped. In attempting to trace its analogies to living animals, however, I have been less successful than in respect to any other animal of the thirty or forty species that impressed the forming new red sandstone of New England. Indeed, the enquiry has recurred to me more forcibly than ever, whether some of these animals may not have combined in their structure, characters now found in several distinct races; as seems to have been the case with some of the Saurians. But this suggestion can be judged of better after describing the footmarks under consideration.

On the same slab with the large tracks, are those of two other species of thick toed bipeds; one of which is the *Brontozoum Sillimanium*, (Ornithoidichnites Sillimani of my Report,) and the other a new species which I have denominated *B. parallelum*, on account of the slight divergence of the lateral toes. I shall first describe the genus Brontozoum, and then this new species, in the manner in which I propose in future to describe all the species known to me.

Fig. 1. Reduced 18 diameters.



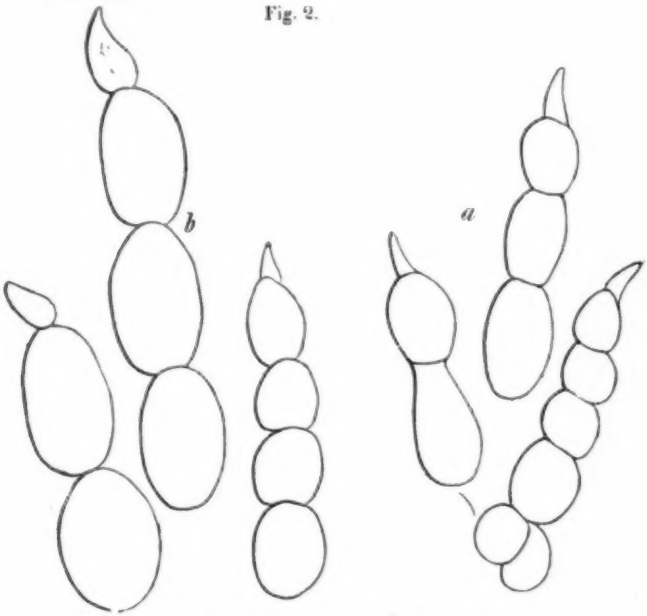
Genus BRONTOZOUM, (βροντης, a giant, and ζωον, an animal.)

Foot tridactylous, pachydactylous, the toes making strong tubercle-like phalangeal impressions; having claws, which in the lateral toes proceed from the outer side, and in the middle toe from the inner side; inner toe shortest: all of them directed forward. Tubercular swellings or phalanges of the inner toe, two; of the middle toe, three; of the outer toe, four. The distal extremity of the tarso-metatarsal bone double-headed; yet rarely reaching the ground: the cushion beneath it, making an impression, which slopes upward posteriorly. Animals bipedal, gregarious.

Five species known: one of them of great size,—with a foot eighteen inches long.

Affinities.—The number and position of the toes, and of the phalanges of the several toes, as well as the manner in which the steps succeeded one another, ally the animals to birds. The deficiency of the hind toe, and the great length of most of the steps, ally them to Grallæ. The great thickness of the toes, and the great size of the feet in some instances, suggest a relation to the Struthionidæ.

Fig. 2.



Brontozoum parallelum. (Fig. 2, *a* and *b*.)

Divarication of the lateral toes, 15° to 20°; do. of the inner and middle toe, 5° to 6°; do. of the outer and middle toe, 8° to

15°. Length of the middle toe, 2 to 3 inches; do. of the inner toe, 1·5 to 2 inches; do. of the outer toe, 1·8 to 2·3 inches; do. of the claw of the middle toe, 0·4 inch; do. of the foot, 3 to 3·5 inches; do. of the step, 13 to 29 inches. Width of the toes, 0·33 to 0·5 inch; do. of the posterior part of the foot, 1 to 1·4 inch. Longest diameter of the double-headed lower extremity of the tarso-metatarsal bone, 0·5; shortest do., 0·27 inch. Length of the middle toe beyond the outer ones, 1·2 to 1·4 inch. Distance between the tips of the lateral toes, 1·5 to 1·6 inch; do. between the inner and middle toe, 1·37 to 1·64 inch; do. between the outer and middle toe, 1·2 to 1·65 inch. Length of the first phalanx of the inner toe, 0·65 to 0·8 inch; do. of the second and third, (supposed to make but one impression,) 0·6 to 0·8 inch; do. of the first of the middle toe, 0·64 to 0·8 inch; do. of the second phalanx, 0·53 to 0·8 inch; do. of third and fourth, 0·4 to 0·8 inch; do. of the first of the outer toe, 0·4 to 0·54 inch; do. of the second, 0·3 to 0·4 inch; do. of the third, 0·26 to 0·35 inch; do. of the two last, 0·33 to 0·45 inch. Tracks in a right line, and the axis of the foot coincident with that line.

Distinctive Characters.—The most striking characters by which the tracks of this animal are marked off from all others, are the near approach to parallelism of the lateral toes, and the great length of the step compared with the size of the foot. This is particularly the fact in respect to the smaller of the outline tracks given on Fig. 2, *a*; for the animal by which this was made, had a stride of two feet: nor is this confined to a single specimen; so that the idea that the animal was running, is not probable. The great disparity between the step in the large specimen (fig. 2, *b*) and the small one (fig. 2, *a*), has led me to suspect that in the above description I may have embraced two species: but their form coincides too exactly to allow of a separation: and yet the large track shows a stride of only 13 inches, while that of the smaller one is 24 inches. The former is from Turner's Falls in Gill, and the latter from South Hadley. I am more disposed to this opinion, from the fact, that I find another row of tracks on the same slab from South Hadley, that contains fig. 2, *a*, running in the opposite direction, and about as large as fig. 2, *b*, yet exhibiting a stride of 29 inches. See the two rows on Fig. 1, *a*, *a*, *a*, *a*, and *b*, *b*, *b*, *b*.

The ratio between the length of the foot and the step in this species, (taking the two examples on fig. 1 as our guide,) is much greater than that of any other animal whose footmarks I have found. That ratio is 8 for the smaller track, and 8·3 for the larger: that is, the step is eight times larger than the foot. Applying the rule which I have suggested for ascertaining from these numbers the length of this bird's leg,* we find it to be 39

* See Final Report by the writer on the Geology of Massachusetts, vol. ii, p. 522.

inches for the smaller animal, and 47 inches for the larger one; that is, from the hip joint to the ground. This is rather more than the length of the leg of the Red Flamingo of this country, which I think also has a larger foot than the fossil bird.

I now proceed to describe the large and extraordinary animal whose tracks occur on the same slab with the B. parallelum, (fig. 1,) but whose affinities to any existing animal are far less obvious. For this remarkable animal I have selected the generic name of *Otozoum*, from that of Otus, one of the fabled præadamic giants. The meaning of Otozoum is, *an animal Otus, or giant.*

The description of the foot of this animal, as we learn it from its footmarks, will depend to a considerable extent upon the zoological class to which we refer it. The protuberances exhibited on the footmark may be all the result of phalangeal impressions; or a part of them may be produced by carpal or metacarpal, or if by the hind foot, by tarsal or metatarsal bones: or if the animal were a bird, by the distal extremity of its tarso-metatarsal bone. Can we then discover to what class of animals these tracks are to be referred?

In the first place, the proof seems quite strong that they must have been made by a biped. This evidence is shown on fig. 1; where it will be seen that the feet regularly alternate as those of a biped would do. But if made by a quadruped, there ought to be two rows, or at least two tracks, near to each other, separated by a longer interval from two others in close proximity: for in one or the other of these modes do most quadrupeds (except those that leap, and those that bring up the hind foot exactly into the place impressed by the fore foot) advance. Besides, the distance of the tracks to the right and left of the animal's general course, is no greater than a biped so large would exhibit: whereas if it were a quadruped, that distance must have been much larger, and the axes of the feet would probably be more divaricate.

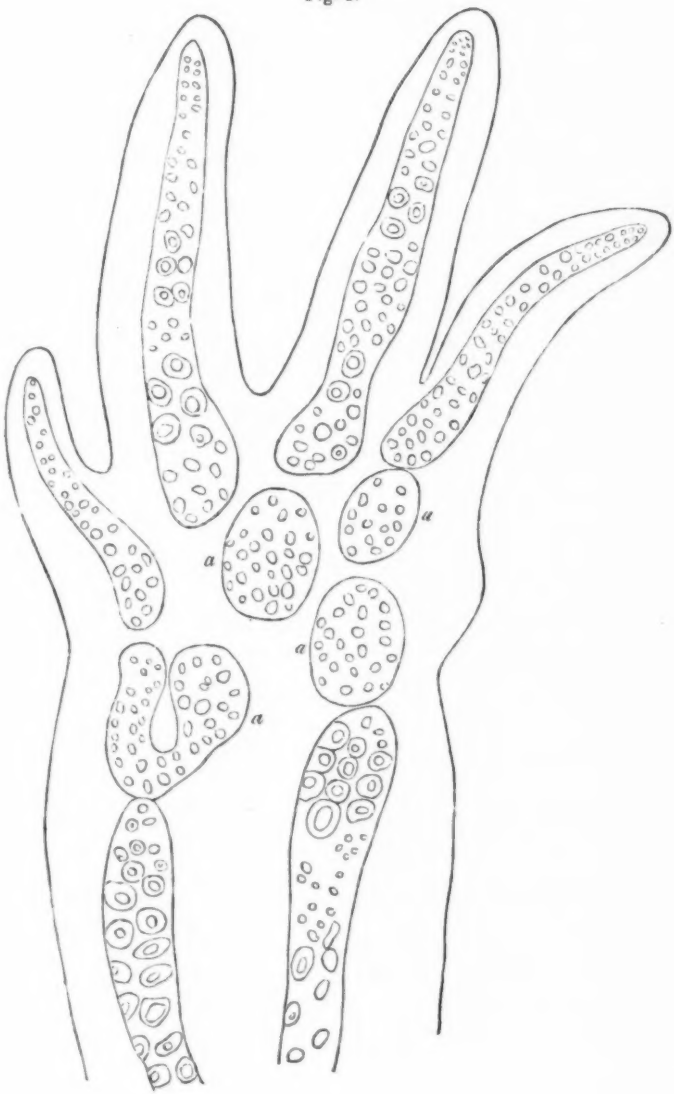
When I saw that these tracks were four-toed, it occurred to me that they might have been made by the hind foot of the crocodile. But their biped character forbids the supposition: and besides, the phalangeal impressions do not agree at all with the phalanges of that animal, which are two in the inner toe of the hind foot, three in the second, and four in the third and fourth.* This latter reason, as well as the number of toes, affords strong evidence against the supposition that this animal was a bird. Some slight resemblance may be noticed between the accompanying drawing, fig. 2, and the feet of the Armadillos, as given in the *Ossemens Fossiles, tome cinquième, Pl. XI, figs.* 10 *to* 14; yet I doubt whether the resemblance is real.

On showing a drawing of this track to Professor Agassiz, he made a suggestion as to the nature of the animal that im-

* Cuvier, Ossemens Fossiles, Tome cinquième, p. 104.

pressed it, which I regard as very important. He at once exhibited to me a drawing of the foot of a recent Batrachian, the *Alytis obstetricans*, in a paper by Dr. Carl. Vogt, while the animal was in an embryo state. This drawing, which I have copied on fig. 3, shows the condition of the forefoot while yet ossification

Fig. 3.



was in an incipient state, or had not begun. The resemblance is certainly rather striking between this sketch and that on fig. 1: and it leads to the suspicion that some of the tubercular impressions of the track may have been made by the metacarpal bones. Such I suppose to be the character of *a*, *a*, *a*, *a*, fig. 3; and when these were fully ossified, it is easy to conceive that they might have been anchylosed into the structure in fig. 1, A.

Professor Agassiz stated a principle of comparative anatomy, in conversation on this subject, which is highly important, viz. that the structure of adult fossil animals, that lived as early as the new red sandstone period, corresponds more nearly with the embryonic structure of existing animals than with their adult development. Taking this principle in connection with the above drawing of the embryo-frog's foot, we are led to the conclusion, that the animal which made these huge footmarks was probably a Batrachian.

It may seem a strong objection to such a conclusion, that the animal was a biped: for what an anomalous being would a biped frog be, with feet twenty inches long! And yet there is one genus of living biped Batrachians, including the *Siren lacertina* of Linnæus; and its feet have four toes in one species, and three in another.* True, these animals have an enormously long tail dragging behind. Yet it is not improbable, that in the new red sandstone period, their bodies may have been more like that of a bird: and such must have been essentially their form in order to have produced the row of tracks exhibited on fig. 1. That biped Saurians existed in the new red sandstone period, we know from the case of the Rhyncosaurus: and the Pterodactyl probably walked for the most part upon two legs. And it is quite as easy to admit the existence of biped Batrachians as biped Saurians. There is also reason to suppose, that some of these animals may have been somewhat intermediate in their characters, and have exhibited, like the Rhyncosaurus and Pterodactyl, a structure now found only in several classes of animals.

Genus Otozoum, (*Ωτος*, the giant Otus, and *Ζωον*.)

Foot tetradactylous, pachydactylous; toes all directed forward: the inner one shortest; the second longer, and the third the longest; the fourth but little shorter: all making distinct tubercle-like phalangeal impressions, the inner toes most so. Phalangeal impressions on mud, three by the inner toe, four by the second, and three by the two outer toes. Two bones of the metacarpus, articulated to the phalanges of the two outer toes, make a distinct impression. Cushion beneath the carpus arching downward, and sloping upward posteriorly. Animal bipedal.

* Cuvier, Règne Animal, Tome ii, p. 120.

Remarks.—It may be that what I have reckoned as the first phalangeal impression on the two inner toes was made by metacarpal bones: and it is also possible, on the other hand, that both the impressions which I have described as having a metacarpal origin on the two outer toes, may have been phalangeal.

Otozoum Moodii. (Fig. 1, A.)

Divarication of the outer toes, 35°; do. of the inner and second toe, 15°; do. of the outer and third toe, 12°; do. of the two middle toes, 5°. Length of the inner toe, 8·5 inches; do. of the second toe, 10·25 inches; do. of the third toe, 8 inches; do. of the outer toe, 8·5 inches; do. of the foot, 20 inches; do. of the step, about three feet. Distance between the extremities of the outer toes, 13 inches. Width of the foot behind the phalanges and metacarpus, 5 inches; do. of the toes, from 2 to 3·25 inches. Length of the phalanges of the inner toe:—proximal phalanx, 3 inches; of the second, 2 inches; of the third, 3·4 inches (?) do. of the second toe:—proximal, 2·4 inches; second, 2·5 inches; of the third, 2·9 inches; do. of the fourth, 2·6 inches (?); do. of the proximal metacarpal bone of the third and fourth toes, 3·5 inches; of the second, 4 inches: of the first phalanx of the third toe, 2 inches; of the second, 2 inches; of the distal, 3·8 inches (?); do. of the outer toe:—proximal, 1·6 inch; of the second, 1·6 inch; of the distal, 5·4 inches (?) Divarication of the axes of the feet, 30°. Distance to the right and left of the middle of the heel, from the average line of direction along which the animal moved, 2·5 inches. Integuments of the bottom of the foot, rugose and irregularly papillose.

Distinctive Characters.—Four thick toes directed forward and making strong phalangeal impressions, distinguish this animal from all others that have left their footprints in the sandstone of New England. The number of phalanges, also, in the toes, separates it from every other. As only one of the tracks of the animal is entire enough for description, I should have suspected some deception in both these characteristics; but sufficient remains of the other tracks, to identify them by their repetition; particularly in respect to the phalangeal impressions of the two outer toes.

Situation and character of the Deposits containing these tracks.—The tracks above described are all in relief, and the rock is a very coarse gray sandstone, the grains being often as large as buckshot. Yet every thing is exhibited most distinctly. Nearly the whole slab is covered with rain drops most beautifully exhibited, and shown upon the drawing, fig. 1. The tracks appear to have been made upon a fine micaceous sand, which has little more coherence now than when the animals trod upon it. But the coarse material that was subsequently brought over this fine

stratum, seems to have adapted itself to every irregularity, and now presents us with perfect casts of the original tracks, while the subjacent rock, which seems to have been a good moulding sand, does not hold together enough to show a single entire track.

It seems that the rows of tracks at this locality were parallel to the edges of the water. They run nearly east and west, and in the direction of the strike of the strata; and in one or two places upon the slab figured above, we can see where the water acted by gentle undulations upon the fine micaceous sand, and upon the coarse grit, partially wearing them both away, or intermixing them; and some of the large tracks look as if the sand had been so wet that the impressions were partly filled up by the sand sliding into them. Only the second track exhibits the outlines of the parts entire. On that, the protuberances rise from one to two inches above the general surface. The extremities of this track have been broken off accidentally, except the inner one which is obscured by lying too near the edge of the water. It is obvious however how far it extended. As I have before mentioned, the second large track on fig. 1, forms the type by which I have restored the others, or rather, completed them; for some of the toes remain in all cases, and so far as they go, they confirm the characters exhibited by the second. It is only a part of the phalangeal impressions that shows the rugosities or papillæ of the skin: yet I can hardly doubt but we have them exhibited on some of the protuberances.

All the left-hand side of the slab, represented on fig. 1, for about half its length, embracing the first two of the large tracks, has been split off an inch or two lower than the other part of the slab. This makes no difference in the large tracks, except to make them stand out in higher relief; but it brings to light several of the smaller tracks, which, although of the same species, must have been impressed at a later period—probably one or two years later—than those scattered among the rain drops.

I have not been able to find any certain example of claws upon the large tracks. Most of the toes are somewhat mutilated at their extremities; and in general, the sides converge rapidly on the last phalanx, so that if claws existed on the foot—and I think they did—they must have been short and blunt.

Circumstances under which the tracks of these animals were made.—Have we any facts in this case indicating the circumstances under which these tracks were made and preserved? It is difficult, without a sketch of the topography of the region, to convey an adequate idea of their situation. The spot is on the south side of Mount Holyoke, which here runs nearly east and west. It curves southerly, however, as it crosses the river, and on the west we have Mount Tom, as the continuation of Holyoke is called. On the east we have a primary range at a short

distance, against which the east end of Holyoke abuts, with only a narrow space between. It is obvious then, that this locality must have been the north shore of an estuary, opening southerly, and extending to what is now Long Island Sound. That it was salt-water is evident from the occurrence of fucoids in the same basin, a few miles south. Now we know that the current through this estuary was either north or south, for the ripple marks have an east and west direction, and in size they correspond with those made by the waters of the Connecticut on the sand in the same region. The direction of that stream also is south; and some have thought that the floods of that stream may have brought in the sand which filled the tracks. But the locality must have been defended from a northerly current by Mount Holyoke, whose elevation doubtless formed the shore on which the animals trod. Indeed, it would be exposed to no current that I can conceive of, sufficiently powerful to move such coarse materials, except the waves and tides from the south. And yet, a deposit at least six inches thick of coarse sand, was brought in over the tracks. It seems difficult to conceive how any river floods should have raised the waters of an estuary enough for this purpose; and more difficult to show how these coarse materials could have been thus brought over this spot. I have hence been rather inclined to suppose that they were silted in by the waves and the tides:—not the daily tides, but the spring tides. Suppose the animals walked along the shore during neap tide, and that no rain fell till the return of spring tide. By that time the mud might have become so indurated, that even such coarse materials might have been brought in by moderate waves, without erasing the impressions. It might be also that the river, which doubtless flowed into this estuary, answering to the present Connecticut, was at the same time swollen; and perhaps also we must resort to the supposition of a subsidence of the locality—an occurrence not uncommon during igneous eruptions: and we know from other circumstances, that the tracks were made about the same period in which Holyoke was erupted. We have evidence also that this period, including some precursory outbursts of the igneous matter, was quite long.

Should time and health permit, I hope to send another communication ere long, describing other new species of tracks in the Connecticut valley. I have no others, however, that are so remarkable as the large one herein described. This, indeed, seems to eclipse that of the *Brontozoum* (Ornithoidichnites) *giganteum*, figured in the Journal of Science for 1836, being even of greater dimensions. I had thought that we had reached nearly the end of this ancient volume; but it may be, that many new chapters will yet be brought to light, when its stony leaves shall be still farther opened.

ART. VIII.—*Glycocoll (Gelatine Sugar) and some of its Products of Decomposition;* by Prof. E. N. HORSFORD.

(Continued from Vol. iii, p. 381.)

COMPOUNDS of glycocoll and sulphuric acid are even more remarkable than those with hydrochloric acid. As little success attended the effort to ascertain the precise conditions under which some of them are formed, as rewarded the labors with the compounds already described. Of these, two, the double sulphate of glycocoll and oxyd of ammonium, and the anhydrous sulphate of glycocoll, have especial interest, as they throw much light over the constitution and nature of this body.

Anhydrous Sulphate of Glycocoll.

$$Gl, SO_3.$$

By dissolving glycocoll in hot spirits of wine, cooling, adding sulphuric acid drop by drop, and setting aside in a quiet place, after a day or two there are formed beautiful elongated thin flat prisms with right angled terminal planes. From another portion the salt crystallized in the most delicate attenuated tables of the greatest brilliancy. It is soluble in water and hot diluted alcohol, and quite insoluble in absolute alcohol and ether. It tastes sour and reddens litmus paper, does not change upon exposure to the air, and loses no weight by 100° C. (212° F.)

Combustion with chromate of lead gave the following results:

I. 0·5147 grm. gave 0·4257 carbonic acid and 0·2509 water.
II. 0·3134 " " 0·2574 " " " 0·1616 "
III. 0·1541 " " 0·1260 " "
IV. 0·3397 " " 0·7039 platin-salammoniac.
V. 0·4248 " " with chlorid of barium 0·4673 grm. sulphate of baryta.

In per cent. expressed agreeing with,

	I.	II.	III.	IV.	V.
Carbon,	22·55	22·40	22·30	. .	. .
Hydrogen,	5·41	5·72	. .	. .	. .
Nitrogen,	. .	. .	. .	13·05	. .
Sulphuric acid,	. .	. .	. .	. .	37·97

Which give the formula

$$C_4 H_4 NO_3, SO_3,$$

as the comparison of estimated and analytical results shows.

		Theory.	Experiment.
Carbon,	4 equiv. = 24	22·66	22·42
Hydrogen,	4 " = 4	3·77	5·56
Nitrogen,	1 " = 14	13·20	13·05
Oxygen,	3 " = 24	22·64	21·00
Sulphuric acid,	1 " = 40	37·73	37·97
	106	100·00	100·00

Repeated combustions did not enable us to lessen the per-centage of hydrogen. The variation from the theory is, doubtless, to be attributed to the absorption in the chlorid of calcium tube, of a small quantity of sulphurous acid, which escaped from the combustion tube. This explanation unfortunately occurred after repeated analyses had consumed the stock of salt.

This constitution is remarkable in the field of organic chemistry. On its borders we have a similar instance in anhydrous sulphate of ammonia, NH_3+SO_3.

Sulphate of Hydrate of Glycocoll.

Gl, SO_3, HO.

This salt was obtained from a solution similarly prepared to that which yielded the anhydrous salt, except that the solution was boiled with sulphuric acid, instead of the latter being added to the cold solution. It crystallizes in short prisms, reminding one of sulphate of copper, and the crystals, though small, are of exceeding beauty and perfection of form. They do not change upon exposure to the air.

A single determination only was made, and *that* of the nitrogen. The other determinations were not made, from want of substance, all subsequent efforts to form the salt having failed.

By Varrentrapp and Will's method:—

0·3367 grm. gave 0·2943 grm. platin-salammoniac.

In per cent. expressed, Nitrogen 12·37.

This corresponds with the formula

C_4 H_4 NO_3, SO_3, HO,

which requires 12·17 per cent. of nitrogen.

Basic Sulphate of Glycocoll.

(a.) 3Gl HO, $2SO_3$, 2HO.

If to a solution of glycocoll in diluted spirits of wine, sulphuric acid in excess be added, and set aside, in twenty-four hours long rectangular prismatic crystals form upon the bottom of the containing vessel. A very considerable excess of sulphuric acid did not change the constitution of the crystals.

They taste and react acid, and like the salts already described suffer nothing from exposure to the air.

Combustion with chromate of lead gave the following results:

I. 0·4199 grm. gave 0·3528 carbonic acid and 0·2149 water.
II. 0·3944 " " 0·3219 " " " 0·1974 "
III. 0·2399 " " by Varrentrapp and Will's method, 0·5067 grm. platin-salammoniac.
IV. 0·6866 grm. gave 0·4928 sulphate of baryta.
V. 0·5808 " " 0·4170 " "
VI. 0·4532 " " 0·3225 " "
VII. 0·4960 " " 0·3500 " "

In per cent. expressed the above determinations correspond with

	I.	II.	III.	IV.	V.	VI.	VII.
Carbon,	22·91	22·25	. .	. .	. .	. .	. .
Hydrogen,	5·68	5·56	. .	. .	. .	. .	. .
Nitrogen,	. .	. .	13·31	. .	. .	. .	. .
Sulphuric acid,	. .	. .	. .	24·62	24·62	24·20	24·40

These numbers give the formula,

$$3(C_4\,H_4\,NO_3, HO)+2(SO_3, HO).$$

The juxtaposition of the estimated per cents. and analytical results follows:—

		Theory.	Experiment.
Carbon,	12 equiv. = 72	22·29	22·58
Hydrogen,	17 " = 17	5·26	5·62
Nitrogen,	3 " = 42	13·00	13·31
Oxygen,	14 " = 112	34·69	34·03
Sulphuric acid,	2 " = 80	24·76	24·46
	323	100·00	100·00

The following formula is submitted as expressing the rational constitution of this salt:—

$$(Gl\,HO, SO_3\,HO+Gl\,HO)+(Gl\,HO, SO_3\,HO).$$

The following sulphuric acid compounds were none of them completely analyzed. They were prepared in small portions while seeking to obtain a neutral sulphate of hydrate of glycocoll; and it was not until the capacity of this body to combine with others of such different nature, and in such varied proportions became fully apparent, that the existence of so complex and unusual compounds was believed.

The crystallized salts were for the most part groups of elongated prisms.

Basic Sulphate of Glycocoll.

(b.) $3Gl, 2SO_3, HO.$

The constitution of this salt differs from that of the preceding in the amount of water. As both of them were dried in the air over sulphuric acid, and suffered no change, this difference is attributable doubtless to the degree of concentration, or difference of temperature. It will be observed that it corresponds precisely with a basic hydrochlorate (d), whose constitution is given on page 380 of the last volume.

With chlorid of barium, 0·2182 grm. of crystals, gave 0·1940 grm. sulphate of baryta.

In per cent. sulphuric acid 27·74.

This corresponds with the formula

$$3(C_4\,H_4\,NO_3)+2SO_3+HO,$$

which requires 27·87 parts in 100. As the probable rational constitution of this salt the following is submitted:

$$(Gl, SO_3+Gl, HO)+Gl, SO_3.$$

Basic Sulphate of Glycocoll.

(c.) $3(Gl, HO)2SO_3, HO$.

A mixture of the salt (b) with the previously described one (a), doubtless gave the crystals for the following determination: 0·3076 grm. gave 0·2300 grm. sulphate of baryta, which gives in per cent. expressed, sulphuric acid 25·65; corresponding with the above formula. The following is more rational.

$$(Gl, SO_3, HO+Gl, HO)+(Gl, HO+SO_3 HO).$$

This requires 25·47 parts of sulphuric acid in 100.

(d.) $2(Gl, HO)+SO_3$.

Another salt gave by combustion with chromate of lead,—

From 0·3039 grm., 0·2872 grm. carbonic acid, and 0·1680 grm. water; which expressed in per cent., give carbon 25·77, hydrogen 6·01. These numbers correspond with the formula

$$2(C_4 H_4 NO_2, HO)+SO_3,$$

which requires carbon 25·26, and hydrogen 5·26.

Glycocoll and Sulphate of Oxyd of Ethyl.

Gl, HO, AeO, SO_3.

The particular circumstances of the formation of this salt, beyond those already given, viz. a solution in hot spirits of wine, or in water to which absolute alcohol was added, are not ascertained.

With chlorid of barium, 0·6470 grm. gave 0·3036 grm. sulphate of baryta: which in per cent. give of sulphuric acid 17·27. This quantity of acid corresponds with the formula

$$C_4 H_4 NO_2, HO+C_4 H_5 O, SO_3,$$

which requires 17·62 per cent. of sulphuric acid.

Nitrate of Glycocoll.

$Gl, HO+NO_5, HO$.

The capability which this compound possesses of uniting with bases enveloped the earlier conceptions of the nature of glycocoll in obscurity:—an obscurity from which the changes the nitrate of copper salt experienced upon subjection to heat, and the simple combinations with the oxyds of silver, copper and lead, did not in any degree relieve it. It was then suggested that the glycocoll played the part of the water of crystallization in the salts that were formed. From the analysis below, it will be seen that the salts were double salts, in which glycocoll with or without water, as a *base*, united with hydrated nitric acid, or as a salt with nitrates of metallic oxyds.

Braconnot obtained this compound by direct combination of nitric acid with glycocoll prepared from isinglass. Dessaigne procured it directly from hippuric acid, employing nitric instead of hydrochloric acid for its decomposition.

We prepared it by dissolving glycocoll in strong nitric acid, and setting the solution over sulphuric acid to crystallize. Occasionally large tabular crystals, apparently belonging to the monoclinate system, are formed. Not unfrequently, however, the salt crystallizes in needles, especially if the fluid has been warmed.

They do not deliquesce upon exposure to the air. They taste and react acid. They were dried over sulphuric acid. Combustion with chromate of lead gave the following results:—

I. 0·4509 grm. substance gave 0·2954 grm. carbonic acid, and 0·1963 grm. water.

II. 0·4968 grm. substance gave 0·3122 grm. carbonic acid and 0·2054 grm. water.

Two analyses, according to Varrentrapp and Will's method, gave respectively 10·04 per cent. and 10·64 per cent. of nitrogen. From this it is evident that this method cannot here be employed:—a fact with regard to nitrates, to which attention has already been drawn by the chemists just mentioned.

Failing in this, a determination was made by the quantitative method of Prof. v. Liebig.

The proportions of carbonic acid to nitrogen in four tubes, were: 17 : 9, 14 : 7, 10 : 5, 24 : 11; or, together 65 : 32 = 2 : 1.

In per cent. expressed the above determinations give

	I.	II.	III.
Carbon, - - -	17·86	17·15	. .
Hydrogen, - - -	4·83	4·59	. .
Nitrogen, - - -	. .	. .	20·50

These correspond with the formula

$$C_4\ H_4\ NO_3,\ HO + NO_5\ HO,$$

as will be seen by the annexed estimates and results of analysis.

		Theory.	Experiment.
Carbon, - - - - -	4 equiv. = 24	17·38	17·49
Hydrogen, - - - -	6 " = 6	4·32	4·71
Nitrogen, - - - -	2 " = 28	20·29	20·50
Oxygen, - - - - -	10 " = 80	58·01	57·30
	138	100·00	100·00

Boussingault by drying the salt at 110° C. (230° F.) obtained as already noticed the anhydrous compound $C_4\ H_4\ NO_3,\ NO_5$.

Oxalate of Glycocoll.

Gl, Ō, HO.

An aqueous solution of glycocoll with oxalic acid, evaporated upon a watch glass, crystallizes in rays reminding one of a cross section of wavellite. If alcohol be added to a solution of glycocoll in oxalic acid, the latter in excess, the solution becomes milky, with the separation of oxalate of glycocoll. If added in small quantities and successively, it crystallizes with the beauty

that characterizes all or nearly all the compounds of this body. Dessaigne obtained the salt directly from hippuric acid by employing oxalic instead of a stronger acid, to effect the decomposition. It does not alter upon exposure to the air.

Combustion with chromate of lead gave the following :—0·3600 grm. gave 0·4227 grm. carbonic acid, which in per cent. expressed, gives carbon 32·02, corresponding with the formula

$$C_4\ H_4\ NO_3, C_2\ O_3, HO,$$

which requires 32·43 per cent. of carbon.

Acetate of Glycocoll.

Gl, HO, $\bar{A}$, 2HO.

This salt is readily prepared by dissolving glycocoll in acetic acid, and adding absolute alcohol drop by drop, till the solution becomes turbid, and then afterward at intervals, as the crystallization proceeds. The salt analyzed was prepared by adding absolute alcohol in excess to a concentrated solution of glycocoll in acetic acid, (the latter in excess,) by which the salt was thrown down. It was then redissolved by heat, and set aside to cool and crystallize, by which slender prismatic crystals of great beauty were obtained.

On combustion with chromate of lead, 0·2981 grm. gave 0·3644 grm. carbonic acid and 0·2031 grm. water, which in per cent. expressed correspond with carbon 33·33, hydrogen 7·57. The formula

$$C_4\ H_4\ NO_3, HO + C_4\ H_3\ O_3 + 2HO,$$

requires of carbon 33·33 per cent. and of hydrogen 6·94 per cent.

Tartrate of Glycocoll.

By dissolving glycocoll in tartaric acid and adding absolute alcohol in excess to the solution, an oily appearing liquid separates and settles to the bottom. Repeated and protracted agitation with alcohol and ether effect no change. This liquid dried upon a watch glass gave a gummy mass which was not further investigated.

Palmatinate of Glycocoll.

By dissolving palmitinic acid and glycocoll in hot spirits of wine, and setting aside to cool, the excess of acid rises to the surface in the form of an oil, while the salt crystallizes in white, thin, silky, radiating scales or blades of the greatest brilliancy. The oily layer, above, which with the whole mass becomes solid, may be readily removed, and the remainder pressed in silk and dried in the air over sulphuric acid. Combustion with chromate of lead gave the following results:

	I.	II.	III.
Carbon, -	51·30	51·23	50·84
Hydrogen, -	9·45	. .	9·44

With these, no formula embracing palmitinic acid and glycocoll has been found. The formula

$$C_4\,H_4\,NO_3,\,C_{32}\,H_{31}\,O_3+12HO,$$

requires 51·31 per cent. of carbon and 11·16 per cent. hydrogen, which would correspond with the carbon, but not with the hydrogen determinations.

Glycocoll and Bi-chlorid of Platinum.

$$Gl,\,PtCl_2,\,2HO.$$

When to a concentrated solution of glycocoll in water, a concentrated solution of bi-chlorid of platinum is added, and then absolute alcohol drop by drop, the solution becomes turbid, and in a very short time, regular cherry-red crystals attach themselves to the sides of the vessel. Or if the concentrated aqueous solution be evaporated over sulphuric acid, after a time, groups of prismatic crystals are formed.

They become instantly covered with a bright colored crust upon exposure to the air, manifestly with the loss of water.

0·3679 grm. substance gave 0·0872 grm. platinum.

In per cent. expressed = 33·03, which corresponds with the formula $C_4\,H_4\,NO_3,\,PtCl_2+2HO$,
which requires 33·26 per cent. of platinum.

Glycocoll and Chlorid of Barium.

$$Gl,\,BaCl,\,2HO.$$

To obtain this salt, equivalents of crystallized chlorid of barium (= BaCl + 2HO) and glycocoll were dissolved in the least quantity of hot water, and suffered to crystallize quietly in the cold. In a few moments the salt crystallized in groups of short prisms of extreme beauty. None were sufficiently perfect to admit of measurement. They appeared to belong to the rhombic system, of the combination $\infty P.\,P\infty.\,\infty P\infty$.

The addition of alcohol to the solution changed the form to that of slender flat needles.

The salt is soluble in water, more so in hot than in cold, tastes bitter, gives neither acid nor alkaline reaction, does not deliquesce or change upon exposure to the air.

Dried over sulphuric acid, 0·6715 grm. substance gave 0·3833 grm. sulphate of baryta, = 55·34 per cent. of chlorid of barium, giving the formula $C_4\,H_4\,NO_3$, BaCl, 2HO, which requires 55·31 per cent. of chlorid of barium.

Glycocoll and Chlorid of Potassium.

$$Gl,\,KCl.$$

This compound was prepared by dissolving glycocoll and chlorid of potassium in water, and evaporating over sulphuric acid.

When the solution had become very concentrated, fine needle-formed crystals filled the whole mass. They deliquesce readily in the air.

A single combustion with chromate of lead, gave from 0·4992 grm., 0·3055 grm. carbonic acid = 16·58 per cent. of carbon.

The formula $C_4 H_4 NO_3$, KCl, requires 16·92 per cent. of carbon.

Glycocoll and Chlorid of Sodium.

A concentrated solution of glycocoll and chlorid of sodium in water, gave upon addition of absolute alcohol and standing a length of time, crystals containing both of the above mentioned ingredients. A quantitative examination was not made.

Glycocoll and Bi-chlorid of Tin.

By dissolving glycocoll in the least quantity of water, and adding bi-chlorid of tin, after a time, crystals containing both ingredients of the solution are formed. They were not more particularly examined.

Glycocoll and Hydrochlorate of Berberin.

Gl, Ber, HCl.

This salt is obtained by adding a hot solution of hydrochlorate of berberin in spirits of wine, to a concentrated solution, in excess, of glycocoll in the same menstruum. Upon cooling, the whole mass becomes solid, and consists of myriads of the most delicate needles, of a brilliant orange color and bitter taste. The salt may be washed with water, as glycocoll is therein readily soluble, while the salt of berberin is not.

The salt dried at 100° C. [212° Fah.] and burned with chromate of lead, gave the following results:

0·1563 grm. substance gave 0·3485 grm. carbonic acid and 0·0826 grm. water, which expressed in per cent. give carbon 60·80, hydrogen 5·87. These correspond with the formula

$$C_4 H_4 NO_3 + C_{12} H_{12} NO_9, HCl,$$

which, containing berberin with the constitution given by Fleitmann,* requires 60·21 per cent. of carbon and 5·03 per cent. of hydrogen.

Glycocoll and Potash.

By dissolving glycocoll in diluted caustic potash and evaporating to syrup consistence over a water bath, crystals in the form of long delicate needles, containing the two ingredients, are formed. They may be rapidly washed with spirits of wine. They deliquesce rapidly in the air, even over sulphuric acid. Dissolved in water, the salt gives a very strong alkaline reaction. It was not further examined.

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* Liebig's Annalen, Bd. lix, s. 166.

Glycocoll and Hydrate of Baryta.

It has already been mentioned, that glycocoll rubbed with pulverized hydrate of baryta, in a mortar, becomes almost instantaneously semifluid. Upon diluting the solution, and setting aside, after a time crystals containing both baryta and glycocoll were deposited. The salt was not analyzed. Its composition, in all probability, corresponds with that of the oxyd of copper, silver and lead, noticed below, and there exist, doubtless, similar salts of strontia, lime and magnesia.

Glycocoll and Oxyd of Copper.

Gl, CuO, HO.

This salt may be prepared by adding to a solution of glycocoll sulphate of copper and caustic potash—and addition of absolute alcohol,—or by dissolving hydrated oxyd of copper, with the aid of heat, in a solution of glycocoll, and adding absolute alcohol:—or lastly by boiling the anhydrous oxyd of copper, in excess, with glycocoll. If the latter be concentrated it must be filtered hot. In this case, the filtrate in a few moments is resolved into a solid mass of the most exquisite cerulean blue color. More carefully examined, it is found to consist of exceedingly delicate needles. The addition of absolute alcohol to the concentrated solution precipitates the whole salt; to the diluted, less perfectly.

At 100° C. [212° F.] 0·5443 grm., at the conclusion of several days, had lost 0·0438 grm. = 8·04 per cent. = one atom of water.

With this loss the color passed through a light green to a shade in which a lavender or violet tint is discernible.

The analysis was made with the substance dried in the air over sulphuric acid.

Combustion with chromate of lead gave the following results:—

I. 0·2030 grm. of substance gave 0·1538 grm. carbonic acid and 0·0912 grm. water.

II. 0·2373 grm. by the method of Varrentrapp and Will, gave 0·4762 grm. platin-salammoniac.

III. 0·1745 grm. gave 0·0592 grm. oxyd of copper.

IV. 0·2871 grm. gave 0·0972 grm. oxyd of copper.

Which expressed in per cent. give

	I.	II.	III.	IV.
Carbon,	20·66	. .	. .	. .
Hydrogen,	4·99	. .	. .	. .
Nitrogen,	. .	12·65	. .	. .
Oxyd of copper,		. .	33·85	33·92

These give the formula $C_4 H_4 NO_3, CuO, HO$, as will be seen by comparing the theoretical and analytical results.

		Theory.	Experiment.
Carbon, - - - -	4 equiv. = 24	20·92	20·66
Hydrogen, - - -	5 " = 5	4·35	4·99
Nitrogen, - - -	1 " = 14	12·20	12·65
Oxygen, - - -	4 " = 32	27·92	27·81
Oxyd of copper, - -	1 " = 39·7	34·61	33·89
	114·7	100·00	100·00

With the loss of an atom of water, we have the salt

$$C_4 H_4 NO_3, CuO,$$

which it will be seen is precisely the composition derived from Boussingault's analysis of the salt dried at 120° C. = [248° F.] See page 373.

Glycocoll and Protoxyd of Lead.

Gl, PbO, HO.

This salt was prepared by dissolving with the aid of heat, protoxyd of lead (obtained from the peroxyd by long continued heat) in a concentrated aqueous solution of glycocoll, and the addition of alcohol till it began to be turbid. In a few hours it separated in prismatic crystals that slowly increased in size for several days, particularly with successive additions of absolute alcohol. The crystals remind one of cyanid of mercury.

A single combustion with chromate of lead gave from 1·3967 grm. substance, 0·6182 grm. carbonic acid, equal to 12·07 per cent. of carbon, corresponding with the formula derived from Boussingault's analysis with the addition of an atom of water,

$$C_4 H_4 NO_3, PbO, HO,$$

which requires 12·83 per cent. of carbon.

Boussingault's analysis was made from the salt, dried at 120° C., [248° F.,] leaving $C_4 H_4 NO_3, PbO$.

Glycocoll and Oxyd of Silver.

Gl, AgO, HO.

If oxyd of silver be added to a solution of glycocoll, it readily dissolves with the application of heat. With the addition of alcohol the above compound crystallizes in wartform crystals, which become dark upon exposure to light.

This salt was not analyzed, as Boussingault's analysis of it, dried at 110° C. [230° F.] as already noticed, gave the formula

$$C_4 H_4 NO_3, AgO.$$

There is scarcely a doubt that corresponding compounds of cobalt, nickel, manganese and iron protoxyds with glycocoll, might with nearly equal facility be prepared.

These compounds are perhaps analogous to those of ammonia with copper and nickel oxyds, when the latter are dissolved in the volatile alkali.

Glycocoll and Nitrate of Silver.

Gl, AgO, NO_5.

If the filtrate from a chlorine determination of the hydrochlorate of glycocoll be evaporated to concentration, and set aside over sulphuric acid, in a little time tolerably regular crystals of the above salt may be obtained.

It may be procured by dissolving glycocoll in nitrate of silver: or by dissolving oxyd of silver in the solution of the nitrate of glycocoll.

Upon melting, it explodes with violence. When exposed to moist air it deliquesces; though it remains unchanged over sulphuric acid.

The salt dried over sulphuric acid, on combustion with chromate of lead:—

I. 0·9300 grm. of substance gave 0·3550 grm. carbonic acid and 0·1880 grm. water.

II. 0·7840 grm. of the same gave 0·2950 grm. carbonic acid and 0·1560 grm. water.

III. 0·6469 grm. of the same gave 0·0258 grm. chlorid of silver.

In per cent. expressed,

	I.	II.	III.
Carbon,	10·11	10·26	. .
Hydrogen,	2·24	2·21	. .
Silver,	. .	. .	49·83

giving the formula $C_4\,H_4\,NO_5$, AgO, NO_5,
as the annexed estimates and results of analysis will show:

			Theory.	Experiment.
Carbon,	4 equiv. =	24	10·16	10·18
Hydrogen,	4 " =	4	1·69	2·22
Nitrogen,	2 " =	28	11·86	. .
Oxygen,	8 " =	64	26·76	. .
Ox. silver,	1 " =	116	49·53	49·83
		236	100·00	

Glycocoll and Nitrate of Copper.

Gl, HO, CuO, NO_5, CuO, HO.

This salt was analyzed by Boussingault, and may be considered as a compound of hydrate of glycocoll with nitrate of copper, united to hydrate of oxyd of copper.

(Gl, HO + CuO NO_5) + CuO, HO.

Glycocoll and Nitrate of Potash.

Gl, KO, NO_5.

This salt forms readily from a solution of glycocoll in nitrate of potash, upon the addition of absolute alcohol. No quantitative analysis of it was made. The above formula is derived from the analyses on page 373.

Glycocoll and Bi-sulphate of Potash.

$$Gl, SO_3 + Gl, KO, SO_3.$$

By dissolving bi-sulphate of potash in water and adding a solution of glycocoll, throwing the whole down with alcohol, re-dissolving by heat and setting aside to cool and crystallize, the above salt is obtained in semi-opaque prismatic crystals.

A single determination from the salt dried over sulphuric acid gave from 0·6873 grm. of substance 0·6200 grm. sulph. baryta. In per cent. giving sulphuric acid = 30·94. The formula

$$C_4 H_4 NO_3, SO_3 + C_4 H_4 NO_3, KO, SO_3,$$

requires of sulphuric acid 30·83 per cent.

Glycocoll and Bi-chromate of Potash.

If glycocoll be dissolved in an aqueous solution of bi-chromate of potash, and absolute alcohol be added till the liquid becomes turbid, and the whole set aside, in a little time crystals will be formed.

These, even under the liquid, in a few days become decomposed, with the deposition of carbon. They were not further examined.

Glycocoll and Urate of Ammonia.

$$Gl, \bar{U}, AmO, \bar{U}.$$

When to a hot filtered solution of urate of ammonia, glycocoll is added, in a little time as the liquid cools, long semi-opaque needles shoot out from the sides of the vessel. The addition of alcohol after the first crystallization, causes the separation of a second portion.

Upon dissolving in hot water equivalents of glycocoll and urate of ammonia, and cooling, a flocculent mass was thrown down, which the addition of alcohol increased, and which, when examined with the microscope, proved to consist of exceedingly minute prisms.

The salt dried over sulphuric acid and burned with chromate of lead, gave from 0·2926 grm. substance, 0·3463 grm. carbonic acid and 0·1144 grm. water, which equal carbon 32·46, hydrogen 4·40. The formula

$$C_4 H_4 NO_3, C_5 N_2 H_2 O_3 + NH_4 O, C_5 N_2 H_2 O_3,$$

requires carbon 32·30, hydrogen 4·61.

Similar flocculent precipitates were obtained from solutions of glycocoll in both urates of potash and soda.

Glycocoll and Uric Acid.

The importance of finding a compound of uric acid that would readily dissolve in water, suggested the effort to combine it with glycocoll.

Two atoms of glycocoll united to two of uric acid would equal three atoms of cyanate of glycocoll:

$C_2\ H_5\ N_2\ O_6 + C_{10}\ N_4\ H_4\ O_6 = 3(C_4\ H_4\ NO_2, C_2\ NO)$,

a compound that may be presumed readily to dissolve in water.

All effort to this end, however, proved unsuccessful. Uric acid remained unchanged in the most concentrated solution of glycocoll, even with the long continued application of heat.

Glycocoll and Benzoic Acid.

As these two bodies exist in combination in hippuric acid, it was to be presumed that a reunion might be effected. To this end, solutions of the two in spirits of wine were made and poured together. After a time the glycocoll on the one hand and the benzoic acid on the other crystallized out.

The same result attended the effort to combine cinnamic acid, cane sugar and neutral phosphate of lime with glycocoll.

(To be continued.)

Art. IX.—*On the Potato Disease.*

Recherches sur la Nature et les Causes de la Maladie des Pommes de Terre, en 1845; par P. Harting, Professeur à l'Université d'Utrecht. Amsterdam, 1846.

De Ziekten der Aardappelen in het Algemeen, door Prof. von Martius. Of de Aardappel Epidemie der Laatste Jaren. Berigten en Meddeelingen door het Genootschap voor Landbouw en Kruidkunde te Utrecht.

The above are the titles of two of the most extended scientific investigations of this subject that have yet appeared. The work of Prof. Harting is particularly valuable, as containing a methodical and extensive series of microscopic observations which seem to have been made with much care and accuracy. It is illustrated by colored plates, showing the tissues, the cells, &c., of the potato in its healthy state, and proceeding through the commencement and various stages of disease.

Prof. Harting is clearly of the opinion that the disease is not to be ascribed to a parasitic fungus; but that the fungus is an effect only, as in the commencement it is never visible and sometimes is wholly absent during the whole progress of the malady. He has distinguished and figured no less than six varieties of these singular plants. The greater part of them belong to the genus Fusisporium of Link. One of them Fusisporium Solani is also described and figured by von Martius. Its characters are:

Floccis fertilibus erectis ramosissimis parce septatis, ramis patentibus, sporidiis terminalibus arcuatis, 4-5 septatis, facile decidentibus.

Another species Spicaria Solani, is thus described.

Floccis albis, decumbentibus dense intertextis, ramulis fertilibus vulgo quatuor erectis, sporidiis minimis ovalibus concoloribus.

Some of these species are only found in the internal cavities caused by disease, others in cavities under the skin through which they eventually pierce and then expand to a very considerable comparative bulk. In one instance and one alone Prof. Harting has perceived the formation of a particular fungus within the sac of a perfect cell; ordinarily their commencement is on the edges of internal cavities among the remnants of destroyed cells. In this instance the potatoes were of a particular variety from the vicinity of Coblence. The fungus belonged to the genus Oidium, (Link,) or Oospora, (Wallworth,) and was named by Prof. H. Oidium violaceum. Its characters are:

Floccis ramosis violaceis, fertilibus in sporidia subglobosa secedentibus. It is therefore quite different from any of the others. Von Martius does not appear to have met with this, but he describes several other distinct varieties. Payen mentions one of the same nature, but of an orange color.

These fungi seem not to be capable of spreading by infection. A large number of experiments were made upon this point; some of their sporules were placed in contact with freshly cut potatoes and allowed to remain in contact under favorable circumstances for many days; in no case was a fungus of the same species reproduced. This would appear to be conclusive, but von Martius and Payen, both obtained results of a different character. In any case we may conclude that it is not a very easy matter to spread infection in this way.

When the brown or black liquid matter, which appearing in the *sacs* of the cells, is the *first* visible proof of disease, is placed in contact with a freshly cut surface, the disease is readily communicated, but not if the skin of the tuber be perfectly sound and unwounded. A very curious additional fact is, that in this way the disease may be communicated to apples, pears, &c.

Both Harting and Martius agree that the disease is not to be ascribed to insects. During the early stages of the disease nothing is to be seen of them or their larvæ. They usually appear at about the same time as the fungi. Ordinarily two species are observed, Glyciphagus fecularum and Tyrogliphus feculæ. Later in the disease, a species of Rhabditis sometimes appears of the same class as those which are found in vinegar, &c. These are only some of the more common varieties which occur.

Prof. Harting has made a partial chemical investigation of the difference between the sound and the diseased portions of the tubers. The reaction of the sound portions was acid, that of the diseased alkaline, with an evolution of ammonia. As might be supposed from this, the quantity of nitrogenous compounds was reduced in the unsound portions, disappearing at last almost

entirely. The brown and black parts contain a greatly increased proportion of insoluble matter; the increase is chiefly owing to the deposition of brownish granular matter, in the cells. This matter is insoluble in water, in ether, in boiling alcohol, in acids or alkalies, and exhibits most of the properties of ulmin, resulting from the composition of the substance contained in the cellular liquids. We will here quote Prof. Harting's words.

"Cette matiére est le resultat des transmutations qu'ont subies l'albumine et la dextrine dissoutes dans le suc cellulaire, et de la fécule, que, après s'être transformée en dextrine, y contribue aussi.

"Il est trés-vraisemblable que c'est l'albumine, qui soit transformée la première, puis la dextrine, enfin la fécule, qui résiste le plus long-temps, et dont l'alteration est encore peu visible même à un état trés-avancé de la maladie.

"Tontes ces transformations chimiques, appartiennent à cette grande série de phénomènes, comprise sous le nom général de fermentation, et qu'on pourrait désigner ici plus particulièrement par le nom *d'humification*, or *d'ulmification*."

He thinks that we may observe the same things every year in apples, pears, &c. The same granular brown matter is shown by the microscope in the cells, and by chemical analysis is proved to be identical with the brown matter of the potatoes.

Prof. Harting, led on by these facts, sought to find in the temperature of the air and earth, the cause of this disease. He has collected a large number of observations upon this point. The winter of 1844–1845 was long and rigorous, and the cold especially severe during March. The equilibrium between the air and the surface of the earth, when a change took place, was thus disturbed, the earth becoming warm much more slowly than the air. The early planted potatoes then found the ground in an unfavorable state. The year 1845 is compared with the preceding years as far back as 1838. The month of March was excessively cold as noticed above, the month of April was a little warmer than the mean of the preceding Aprils; May was very rainy, and the temperature below the *minimum* of preceding years. June, on the contrary, was very hot, above the former maximum, July was also very warm with much rain, so that the potatoes grew with much rapidity. The variations of the barometer were not greater than ordinary, but the case was far otherwise as to the humidity of the air and the pressure of vapor. During the months of July and August, the relative humidity was above the maximum of the same months in preceding years; in those years also the pressure of vapor was less at two in the afternoon than at eight in the morning, but in 1845 this rule was reversed. The malady in Holland ended in the month of July, and after the middle of that month the above differences were not more perceptible. The great heat of the air and excessive moisture caused a rapid developement of the plant, and of course

an increased transpiration was necessary, but was always checked by the increased pressure of vapor in the middle of the day; this of course deranged the circulation and caused the liquids in the circulation to begin to ferment. This view is supported by the fact that in Holland the parts first attacked were the leaves and stalks, the parts more directly in contact with the air. In Scotland and some parts of Prussia the disease made its appearance in September, for the most part; the temperature of the earth was then higher than that of the air, and accordingly the disease generally attacked the tubers first. But when we acknowledge all of these extraordinary facts, we still are forced to look for some special predisposition to disease among the potatoes themselves. In what this special predisposition consists, it is not easy to say.

It has not been the same in all species of potatoes, some have almost escaped while others of another kind in the same neighborhood have been almost utterly destroyed; it must reside in the plant itself, either in the structure of its tissues, or in the chemical state of its juices. It has been noticed that the potatoes of late years have had a much greater tendency than usual to germinate. This indicates an unusual molecular movement in the juices, which under the influence of moisture and the atmosphere, in place of changing the starch into dextrine and dextrine into cellulose, ferments and causes the disease.

Potatoes planted during the early morning have in some instances been almost entirely free from the malady, while those of the same variety planted in the afternoon, after lying in the sun sometime, were almost all destroyed. In this case, it seems possible that the heat of the sun gave a movement to the juices and prepared the way for the subsequent attack.

Von Martius describes two distinct kinds of disease, De Drooge kankerachtige Ziekte der Aardappelen, the dry canker disease of the potatoe, Gangræna tuberum Solani; and "De schurftachtige Ziekte der Aardappelen," the scabby disease of the potatoe, Porrigo tuberum Solani.

Prof. Harting's results and suggestions certainly furnish ample ground for very probable theories as to the cause of this disease, and indicate the course to be taken in future investigation. If, as seems possible, atmospheric influences induce such chemical changes in our growing crops, though we have found a cause, we have not found a remedy; to guard field crops from atmospheric changes is not an easy matter.

Such changes may occur only at long intervals of years, but the fact of their occurring at all, will be a warning to the nations not to place their sole dependence on a single crop. Unhappy Ireland and the north of Scotland are mournful examples of this mistake.

J. P. N.

Utrecht, April 25, 1847.

ART. X.—*Report on Meteorites;* by CHARLES UPHAM SHEPARD, M.D., Professor of Chemistry in the Medical College of South Carolina, and in Amherst College, Mass.

(Continued from Vol. ii, ii Ser., p. 392.)

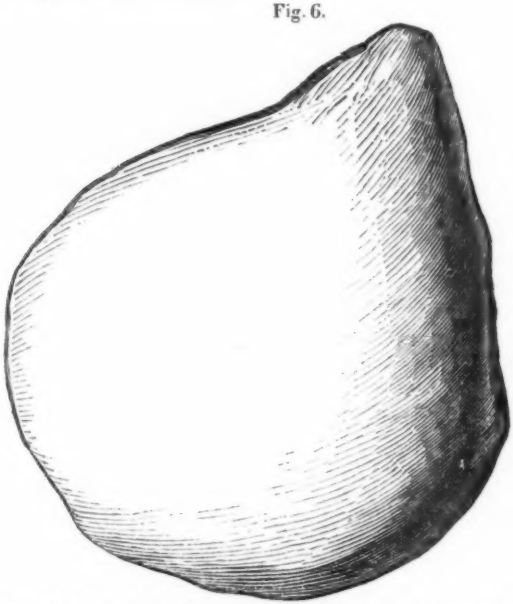
CLASS II. METALLIC.

ORDER FIRST. *Malleable, homogeneous.*

Section 1*st.* PURE.

1. *Walker county, Alabama.*—This mass was described by Dr. TROOST in Vol. xlix, p. 344, (1845.) Through the assistance of Dr. I. F. SOWELL, of Athens, Ala., I am able to supply a few additional details, concerning the occurrence of this unusually interesting specimen. Dr. Sowell observes, that "the existence of this iron was made known to me in 1839 or '40; and I was in treaty for it during two or three years, before being able to obtain possession of it. The original mass was irregularly oval, resembling the figure here sketched.

Fig. 6.



"It was without any abrupt prominences or depressions, and was covered by a smooth, black crust. It was found with the larger end buried in the ground, leaving a portion of the smaller extremity projecting above the soil,—suggesting the idea, that it was driven into the ground by the force of its fall. Upon this small-

er end, the finder (Mr. Speaks) placed his foot to rest, while abroad on a hunting excursion. Its unusual appearance attracted his attention, and led him to remove it to his house as something valuable. The mass was found remote from any settlement, in an uncultivated and rather unfrequented region. Its weight was one hundred and sixty-five pounds."

This iron does not afford by etching, the Widmannstättian figures; although it exhibits glistening freckles, or angular spots of the size of fine-grained gunpowder, which are occasionally intermingled with shining lines and fibres. Sp. gr. = 7·265.

It consists of iron 99·89, with traces of calcium, magnesium and aluminium, in the order, as to quantity, in which they are enumerated,—the calcium being most abundant.

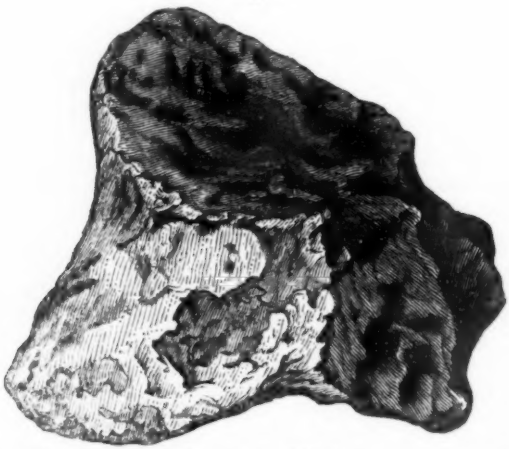
2. *Scriba*, (*Oswego*,) *N. Y.*—My description of this mass was published in Vol. xl, p. 366, (1841.) To that account may now be added the statement of Mr. John G. Pendergast, communicated to me in a letter dated July 15, 1846. "I saw a mass of iron at Oswego in 1834, in the possession of Mr. Rathbun, (a blacksmith,) which I judged to be meteoric. Mr. R. had obtained it on that day from his collier, who had been down to deliver a load of charcoal, and stated that he found it in the woods, some where in the vicinity of his coal-pit. The circumstance of its being found in the forest, together with its size and form, induced me at the time to believe it to be meteoric iron. The mass in all probability, was originally globular in form, but from having been highly ignited, and striking the earth (perhaps on a stone) with great force, a flattening in its shape was produced, like that which would be occasioned in a round lump of putty, if thrown against a board. I was fully satisfied that the form it possessed, could have been imparted in no other way."

The foregoing contains but little beyond the testimony of a second witness, to the conditions under which the mass was found. It appeared important however, to omit no circumstance relative to its discovery, for the reason that it does not possess that peculiar chemical composition, which has heretofore been regarded as confirmatory of the extra-terrestrial origin of similar productions, and on which account, I hesitated in my first notice to include it among undoubted meteoric irons. Its resemblance however, to the Walker county, Ala., iron, not only in composition, but in the generally smooth surface and black color of its crust, and still more, in the freckled figures developed upon its polished sections by nitric acid, establishes an analogy of the most marked kind between the two bodies. And as it seems unreasonable to ascribe the large drop-shaped mass of Alabama, either to a terrestrial or an artificial source, I feel authorized in claiming a meteoric origin for them both.

Section 2d. ALLOYED. *Sub-section,* CLOSELY CRYSTALLINE.

3. *Babb's Mill, 10 miles north of Greenville, Green county, Tennessee.*—This mass was described by Dr. TROOST in Vol. xlix, p. 342, (1845.) Judge PECK has afforded me (under date of Dec. 14, 1845) some additional particulars, relating to the locality, from whence he had obtained a specimen, in its natural condition. His remarks are as follows: "Of the two masses found in Green county, the first, as well as I can recollect, weighed twelve or thirteen pounds; the other which I have, weighs upwards of six pounds. The former was injured by having been heated and cut. It exhibited however, a crystalline structure, when small portions were torn or broken asunder, though the grains were very small. It was homogeneous; and formed as malleable and tough an iron, as I have ever seen. The second mass (of about six pounds) I was fortunate enough to obtain, just as it was found."

Fig. 7.



This specimen was in the most obliging manner transferred to me, in exchange, by Judge Peck; and with the exception of a few hundred grains taken from an angle, has been preserved precisely in its original shape. It exhibits in the most perfect manner that peculiar moulding (consisting of somewhat irregular basin-shaped depressions of various sizes, connected with blunt rounded angles and edges) which marks so many of these productions.* A wood-cut does but inadequately render these appa-

* Having observed that this kind of surface occurs in masses of artificial iron, both cast and malleable, if it have been a long time exposed to the action of weather, (as in iron palings and posts, as well as in old cannon,) I cannot avoid attributing the pitted, indented outside of the meteoric irons, in part, to terrestrial influ-

rent. The black coating of oxyd of iron, so often investing meteoric iron, is here nearly replaced by broad patches of a thin, yellowish, ochrey brown incrustation.

Sp. gr. =7·548. It is close grained and perfectly compact, taking a very high polish, and exhibiting at the same time, a color rather whiter than that of steel. It shows no crystalline figures on being corroded with nitric acid; although on very close inspection, minute, whitish spots, (isolated and collected into patches,) may be seen here and there, scattered without order over the surface. When broken, it presents a fine granular texture, attended by a high silvery lustre.

Dr. TROOST found the mass he obtained to contain, iron 87·58, nickel 12·42, remarking however that the ratio of the nickel given was probably too high, and that the compound might contain other ingredients. My own specimen affords me, iron 85·30, nickel 14·70, with traces of calcium, magnesium and aluminium.

4. *Claiborne, Alabama.*—Vol. xxxiv, p. 332, (1838.) Vol. xlviii, p. 145, (1845.)

5. *Livingston county, Kentucky.*—Vol. ii, ii Ser., p. 357, (1846.)

6. *Dickson county, Tennessee.*—Vol. xlix, p. 337, (1845.)

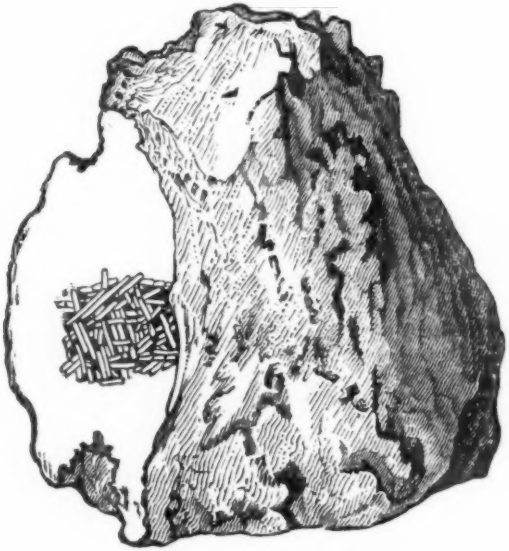
7. *Texas, (Red River.)*—Vol. iii, p. 44, (1821.) Vol. viii, p. 218, (1824.) Vol. xvi, p. 217, (1830.) Vol. xxvii, p. 382, (1835.) Vol. xxxiii, p. 257, (1838.) Vol. xliii, p. 358, (1842.) Vol. ii, ii Ser., p. 372, (1846.)

8. *Burlington, Otsego county, N. Y.*—This mass (originally 150 lbs. in weight) was described by Prof. SILLIMAN, Jr., in Vol. xlvi, p. 401, (1844.) It was ploughed up by a farmer, near the north line of the town, sometime prior to 1819. Portions were cut from it, from time to time, by the discoverer's blacksmith, for agricultural uses; until its weight was diminished to about a dozen pounds, when it fortunately fell into the hands of Prof. Hadley, of Geneva, N. Y., to whom I am indebted for a conical lump, (weighing nine pounds,) which must have formed a somewhat pointed extremity of the original mass. From the base of this, a slice was taken, leaving a lump of five pounds of the annexed form. Its sides show for the most part, the natural crust of the iron; but where this is not the case, the surface has been cut and polished, or is coarsely crystalline with large tetrahedral and sub-hackley faces, occasioned by the breaking off of what were apparently projecting prongs. Its polished faces show a very high lustre, with a color of nearly the same whiteness as German silver. Held at a proper angle, they discover very distinctly the same crystalline characters, which are still more distinctly brought out by the ac-

ences, which have acted upon masses not perfectly homogeneous either in composition or in density. For this reason perhaps, the Lockport iron, which is very much charged with amygdaloidal kernels of magnetic iron pyrites, presents an uncommonly pitted and jagged surface.

tion of acids. The etched surface is illustrated in the accompanying figure. The pattern is strikingly peculiar, as well as beautiful. The bright shining veins, which resist the action of the acid, are rarely nearer together than the $\frac{1}{15}$th or $\frac{1}{20}$th of an inch;

Fig. 8.



and these in place of being continuous, are interrupted at frequent intervals. In their course also, they frequently exhibit little triangular enlargements, the sides of the triangles curving inwards. The surface included between the shining lines, and which forms at least $\frac{9}{10}$ths of the whole, is every where finely freckled as if depending upon a granular texture, and even bears some analogy to what is familiarly known as crystallized tin, or *Moiree metallique.*

Its hardness is very unusual, no iron with which I am acquainted offering on the whole, so much resistance to the operation of slitting. Mr. Rockwell gives as its composition, iron 92·291, and nickel 8·146. My own result in a single analysis, is as follows:

Iron, ...	95·200
Nickel, ...	2·125
Insoluble, ...	·500
Sulphur and loss, ...	2·175
	100·000

Sub-section, COARSELY CRYSTALLINE.

9. *De Kalb county, Tennessee.*—Vol. xlix, p. 341, (1845.)

10. *Asheville, (Baird's plantation, near French Broad River, six miles north of Asheville,) Buncombe county, North Carolina.* —Vol. xxxvi, p. 81, (1839,) and Die Meteoriten, von P. PARTSCH, Wien, 1843, s. 116.

As this county has of late afforded two other localities of meteoric iron, I have taken pains to ascertain as nearly as possible the exact position of each. The Hon. T. J. Clingman informs me, that this locality is six miles north of Asheville, on the estate of Col. Baird, who is of opinion that other fragments may there be found, as he has within two years observed small pieces of rusty iron in the same field from which Dr. Hardy's mass was obtained.

Farther experiments on the composition of this iron, enable me to add to what was before made known, that it contains cobalt, magnesium and phosphorus; and that the nickel is sometimes present in a ratio as high as 5 p. c., while the silicon is considerably below 0·5 p. c., as formerly quoted.

11. *Guildford county, North Carolina.*—Vol. xl, p. 369, (1841,) and Die Meteoriten, von P. PARTSCH, s. 114.

12. *Carthage, Tennessee.*—Vol. ii, ii Ser., p. 356, (1846.)

13. *Jackson county, Tennessee.*—Vol. ii, ii Ser., p. 357, (1846.)

ORDER SECOND. *Malleable, heterogeneous.*

Section 1*st.* AMYGDALOIDAL.*

14. *Hommoney Creek, near base of Pisgah Mountain, (ten miles west of Asheville,) Buncombe county, North Carolina.*

The present iron was brought to light through the perseverance of the Hon. T. J. CLINGMAN, of Asheville, to whose liberality I am indebted also for the possession of so interesting an object. He informed me in March, 1846, that while in the adjoining county of Haywood, he had accidentally been told by a Mr. Clarke, that his son had a mass of ore, five or six pounds in weight, that was very black and heavy, and which they could not break with a sledge-hammer, though they were able to indent its surface. Mr. C. was disappointed, on visiting the son, to find the piece had been mislaid and probably lost. His description however, agreed closely with that given by the father. He learned also from the young man, that the mass had the appearance of

* The present mass having been discovered since the classification of the previous paper was made, it becomes necessary to create a new section for the reception of this remarkable variety. In some respects, it resembles the amygdalo-peridotic species from Siberia and Atacama. It differs however, from them both, in the more diminutive cavities, and still more in this, that these cavities are almost completely empty. The term amygdaloidal therefore, is here applied, in analogy with its use in geology, for describing the vesicular traps.

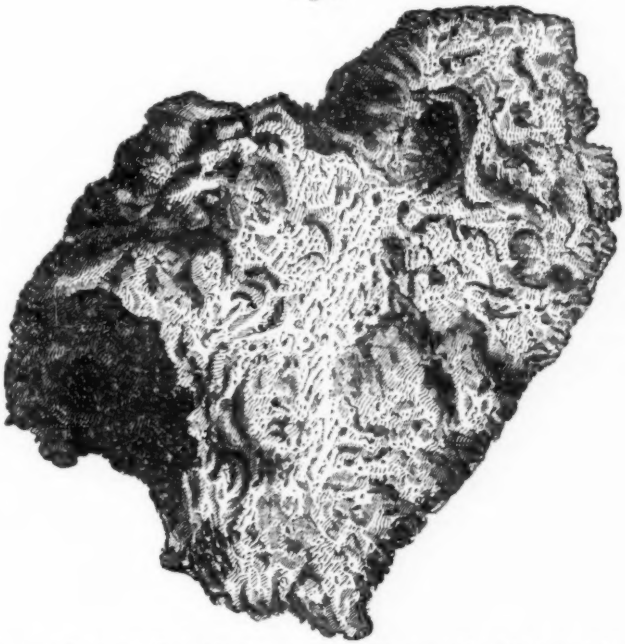
having been melted, one side being flattened, while from other parts of it, there were projections ("spurs") as long as a man's finger, which he could batter down with a stroke of the hammer. He said he obtained it a year before in Buncombe county, in a field, where he was of opinion that more of the same might be found. Mr. C. afterwards visited the neighborhood in which the specimen occurred; and was there assured by a young man, that he had seen the piece that the Clarkes had described, and that he knew of another much larger piece, similar to it, at an old house on the Clarke farm, where the smaller had been found.

On procuring the mass, (which weighed nearly twenty-seven pounds,) Mr. C. communicated to me the following particulars respecting it, which may perhaps be given in this place as generally descriptive of its aspect. "It is rather flat on one side, as though it had been laid when semi-fluid on a somewhat plane surface, while its other sides are irregular, with cavities and various inequalities. It has no appearance of ever having been hammered, and externally looks like a cinder from a blacksmith's fire." (At first, from not having seen any vesicular meteoric iron, Mr. C. was led to question its genuineness.) "But it is too large, and much too heavy to be compared with cinder. It has some malleability, though it may be broken if struck on its thinner projections and edges. Its knotted appearance, toughness and malleability, together with the peculiar form of the broad side, or bottom, and that of the large end, indicating that a greater than human force must have been applied to the mass, and evincing that it was cleft by an explosion from some large body, lead me on the whole, to rest in the inference, that it is of foreign origin." Mr. C. likewise remarked, that its external appearance would be well conceived of, if we supposed an ordinary mass of meteoric iron to be thrown into a forge-fire, and when thoroughly fused at its surface, suddenly to be withdrawn and cooled.

Its shape may be judged of by the figure on the opposite page. As frequently happens with these productions, a general conception may best be obtained by likening them to some familiar objects: this specimen strikingly reminds one of the head of a reptile. As figured, it reposes on its flat and broad side, and the dark shadow at the left, is in the place of the nearly vertical section, supposed to represent the junction of the animal's head with its body. It measures eleven inches in length, by seven in breadth; and is four in thickness at the thicker end, while at the upper extremity of our figure, it is not above two and a half, and on the right and lower edge, it thins down to little above one inch. Its surface is rather tuberose and jagged, than pitted with regular depressions. Color various shades of brown to black, and somewhat variegated (especially in the bottoms of the cavities) with

an ash colored earthy matter. This last was undoubtedly derived from the circumstance, that the mass was for a considerable time employed as a support for fuel in the fireplace of a farmer's kitchen. Upon the under side, there adheres over a few inches,

Fig. 9.



a crust of an earthy, black amygdaloid, scarcely distinguishable, unless freshly broken, from the iron itself; and in one spot, nearly buried within the substance of the iron, a few grains of a dull, yellowish, gray olivine were noticed, similar to those found in the Bitburg iron. Near the surface, and especially upon the thinner edge and at the small extremity of the mass, its structure is eminently vesicular, the cavities being from one-fourth to one-twentieth of an inch in diameter, sometimes distinct, at others running together, and generally lined with a black powder. But as the distance increases to an inch from the surface, the cavities grow smaller and more remote from one another. No deeper section than one inch has yet been made in the mass; it is therefore possible, that the central portions may be nearly compact. The fresh fracture has a color and lustre, intermediate between steel and magnetic iron-pyrites. Etched surfaces, excepting where the structure is highly vesicular, exhibit the most delicate Widmannstättian figures, consisting of very minute and thickly

interspersed triangular figures, distinct enough to be easily seen with the naked eye, but under a microscope exceedingly beautiful. They resemble somewhat in this respect, the Bitburg iron, to which it also approximates in the tuberose conformation of the exterior surface.

Hardness about that of grey cast iron. Sp. gr. = 7·32.

It is composed of iron, (with traces of chromium and cobalt,)	98·19
Nickel, ...	0·23
Carbonaceous, insoluble matter and loss,	1·58
	100·00

The yellowish, olivine-like grains consist of silicic acid, lime, magnesia, and oxyd of iron.

Section 3d. Amygdalo-pyritic.

15. *Lockport, (Cambria,) New York.*—Vol. xlviii, p. 388, (1845.) Vol. ii, ii Ser., p. 374, (1846.) In addition to the nickel, copper, phosphorus and silicon, found in this iron by others, I have detected cobalt.

Section 4th. Pyrito-plumbaginous.

16. *Black Mountain, head of Swannanoah River, eastern line of Buncombe county, (fifteen miles east of Asheville,) N. C.*—My first knowledge of this iron was derived from a remark, contained in a letter from Hon. T. J. Clingman, dated Feb. 17, 1846, to the following effect: "Dr. Hardy informs me that he gave a very remarkable looking specimen of meteoric iron found in this county, (Buncombe,) to the late Col. Nicholson of Charleston, S. C., who died at Abbeville in that state, six or seven years ago." Being in Charleston, I applied to the executors of Col. N. for information respecting that portion of his effects, which would be likely to include this specimen; but my inquiries were without success. Previous to this date however, I had been informed by Prof. Tuomey, who was then the state geologist, that he had seen a specimen of malleable iron in the cabinet of Dr. Barratt of Abbeville, which led me to address a letter to this gentleman, relative to the subject, from whom I received the following note, dated June 1, 1846, accompanied by the specimen itself. "I can furnish you with little that is definite concerning its history. The year Col. Nicholson, of Charleston, died, he had obtained it in Pendleton or Greenville District. It was given to him by some person, who had picked it up as a meteorite. Col. N. gave it to me, as I was the only person in this part of the country who preserved such objects. I believe it to be meteoric in its origin, and as such it has had a place in my cabinet. To yourself and to science, it is most cheerfully tendered."

On communicating a description of the mass to Dr. Hardy, he replied, "I have no doubt that the specimen referred to is the same which I gave Col. Nicholson. It was found at the head of Swanannoah river, near the base of Black mountain, towards the eastern side of Buncombe county."

The fragment weighs only twenty-one ounces: and, judging from the size and shape of that side which still exhibits the natural outside of the meteor, it is evidently a portion of a mass that must have been much larger. Its texture is throughout, highly crystalline, having all the laminæ (which are unusually thick) arranged conformably to the octahedral faces of a single individual. These layers, which commonly have a thickness of one-tenth of an inch, adhere to one another with much tenacity, so as not to be separable by any ordinary force. They manifest a slight tendency however, as the result of weathering, to separate into granular portions of the thickness of the layers themselves; the particles being somewhat oval in form—a result which seems to flow from the existence of very minute veins of magnetic iron-pyrites: for when a surface of the iron is polished, it exhibits the appearance of being mapped off into rounded patches by thin veins of the pyrites; and on the application of nitric acid this structure is still farther developed by the corrosion of the veins. Within these areas, the structure of the iron, when etched, scarcely seems crystalline; at most, exhibiting a few faintly marked crossing lines. A somewhat similar structure is visible in the Cocke county iron.

The mass contains several rounded and irregular nodules of plumbaginous matter, (from half to one inch in diameter,) with which again (and often situated in the midst of the kernels) are found large pieces of foliated, magnetic iron-pyrites. In this respect also, the present iron is closely related to the Cocke county iron.

Its sp. gr. = 7·261.

It consists of nickel, (with traces of cobalt,) .	2·52
Iron, ...	96·04
Insoluble matter, sulphur and loss, . .	1·44
	100·00

17. *Cocke county, Cosby's Creek, Tennessee.*—For our earliest notice of this truly wonderful locality of meteoric iron, we are indebted to Dr. Troost, (see Vol. xxxviii, p. 250, 1840,) and for an additional account of its composition by myself, see Vol. xliii, p. 354, (1842.) The history of this locality is still farther illustrated by the following particulars, derived from two letters from Judge Jacob Peck of Jefferson county, Tennessee, the one dated July, 1845, and the other December, of the same year.—Extract from the former, which was addressed to

Dr. J. H. Kain of this city: "The large mass of meteoric iron found some years ago in Cocke county, (on a creek called Cosby's,) fell into the hands of some persons who tried to break it with sledge-hammers, but not succeeding, they placed it upon what is here called a 'log-heap,' where after roasting for some time, it developed certain natural joints, of which advantage was taken with cold chisels and spikes, for its separation into fragments. These were put into a mountain waggon, and transported thirty or forty miles to a sort of forge, and there hammered into 'gun-scalps,' and other articles of more common use. Some remnants of the mass fell into the hands of Dr. Troost. The original mass was one of rare character, and ought to have been preserved entire. Much of it was composed of large and perfect octahedral crystals. Its weight was about a ton. Another mass weighing one hundred and twelve pounds, was found near the locality of the larger one. This also was malleable, very white, and easily cut with a sharp instrument. It was picked up by a mountaineer, who supposing it to be silver, asked fifteen hundred dollars for it. After retaining it for some years, he finally sold it to a friend of mine for a small sum, who transferred it to Dr. Troost."

Extract from the letter of December, 1845, to myself: "The weight of the mass has been, variously estimated; but I am certain it was never weighed, prior to its being broken up. It was probably about two thousand pounds. In figure, it was an oblong, square block. I saw several very regular octahedral crystals that had been detached from the exterior angles of the mass. I had formerly supposed that the whole of it had been taken to Lary's forge, in Sevier county, and the greater part of it there wrought into 'gun-scalps;' but very recently, I have been informed, that part of it was taken to the forge of Peter Brown, in Green county, and there forged. I understand that a man by the name of McCoy, had a neat bar forged from it for making a gun-barrel, which, to use the expression of Brown's son, 'was as bright as silver.' In the conversation, young Brown informed me that he thought a piece of the iron in its natural state still remained. On searching, it was found by a little girl of the family. It weighs rather more than a pound, and had been preserved by the family as a nut-cracker.*

"The great mass was found on a hill, or rather on an offset of an eminence, at about one hundred feet above the bed of Cosby's creek. I was at the place after the mass was taken away. The formation was a hard clay-slate, and very little impression was left at the spot, except some stains of red oxyd of iron. McCoy,

* This specimen I owe to the kindness of Judge Peck.

who claimed to be the owner of the land, took me there, under the impression that I should be able to aid him in discovering a mine of pure iron near the spot, especially, as the mass of one hundred and twelve pounds was found in the same immediate vicinity. The search of course was to no purpose. The mass of one hundred and twelve pounds appeared to me to be identical in character with the fragments I have seen of that supposed to weigh a ton."

The sp. gr. of this iron, as given by Partsch, (Die Meteoriten, p. 151,) is 7·26. I have found that of the included magnetic iron-pyrites, to be 4·454.

Order Third. *Brittle.*

Section 1st. Pure.

18. *Randolph county, North Carolina.*—This mass (originally two pounds in weight) was described by me in Vol. xvii, p. 140, (1830,) as native iron. It had been previously mentioned in Vol. v, p. 262, (1822,) by Prof. D. Olmsted, in a descriptive catalogue of rocks and minerals collected by him, during his geological survey of North Carolina. It is spoken of by Prof. O., as occurring in the vicinity of a bed of argillaceous iron ore. It is distinctly foliated, the laminæ being thin and much interlaced. Color and lustre resembling those of mispickel. When etched, it presents very fine, almost invisible, feathery lines, much resembling hoar frost on a window pane. Hardness equal to that of the best tempered steel. Sp. gr. = 7·618. The only metal I have been able to detect in this steel, is cobalt, and this only in traces. A reddish brown powder, not soluble in nitro-hydrochloric acid, did not communicate any color to a bead of borax, which led to the suspicion that it was silicon.

19. *Bedford county, Pennsylvania.*—This variety was described in Vol. xiv, p. 183, (1828,) as native iron, slightly arsenietted. It closely resembles the Randolph county specimen, in structure, color, hardness and lustre. Its sp. gr. = 6·915. In the few grains at my command for its examination, I have been unsuccessful in verifying the existence of arsenic, or of detecting the presence of any other metal, besides iron. Still, its greater analogy to the Randolph iron than to any other terrestrial production, either natural or artificial, induces me to retain it in the category of meteorites.

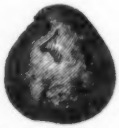
Section 2d. Alloyed.

20. *Otsego county, New York.*—The precise locality of this very curious iron cannot at present be given. It came into my possession under the following circumstances. Two or three persons from Otsego county submitted a number of specimens to

Dr. JAMES R. CHILTON, practical chemist of New York, for determination, stating that they had collected them in that region. Among the collection was the iron in question, which they described as having been picked up by them in the soil. They were of opinion, that it was some valuable metal; and were only satisfied that it was iron, by being shown by Dr. C., that it adhered strongly to the magnet. Dr. C. was at once led to suspect that it was a meteoric production, from the peculiarity of its shape; and induced the proprietors to exchange it for several specimens of silver ores, which they were desirous of procuring, to enable them to prosecute their mining researches with more intelligence. By paying Dr. C. the value of the specimens he had given for it, he very kindly transferred it into my hands.

Its weight was 276 grs., and its figure almost spherical or drop-like, as represented in the margin. It was covered with a black coating, save on one side, where it had been partially polished. The application of a drop of dilute nitric acid to this side, brought into view the most beautiful, raised lines, closely compacted together, and crossing each other in every direction. Its hardness was too great to allow of its being sawn; it was therefore broken upon an anvil (within a closed ring of iron) by means of heavy blows with a sledge. Its structure within, is foliated, or foliated-columnar, the individuals radiating from the centre to the circumference. Its color when first broken, was a light steel-grey, with a faint yellowish or reddish tinge, somewhat analogous to magnetic iron-pyrites. Interspersed through the mass, a close inspection discovers very minute, perfectly round globules of magnetic iron-pyrites, the number of which is much increased by the aid of the microscope. These globules are easily detached, and leave behind cavities with smooth, silvery colored walls. A polished surface of its interior, on being etched, exhibits a very exquisitely beautiful crystallization, consisting of innumerable, closely compacted, silvery lines, crossing each other in various directions, but rarely forming regular triangles, as in the malleable irons, (but more resembling the brittle irons of North Carolina and Pennsylvania,) more or less spotted with black globules of pyrites.

Fig. 10.



Being anxious to preserve as much as possible of this smallest of all the known meteoric iron-masses, I have contented myself with such inferences as a solution of less than twenty grains, enabled me to make respecting its composition. It dissolves with difficulty in nitro-hydrochloric acid, at the same time evolving sulphuretted hydrogen, leaving behind minutely divided carbon (plumbago) and a heavy whitish powder. This latter, fused with carbonate of soda on charcoal, gave what appeared to be metallic tin. The clear solution saturated with ammonia, afforded per-

oxyd of iron that corresponded to 94·57 per cent. of metallic iron; and the solution possessed an intensely azure blue color, which I ascertained to proceed chiefly from the presence of copper, though nickel and cobalt were also both detected in the liquid. This little meteorite, therefore, contains the following elements:—iron, copper, nickel, cobalt, sulphur, carbon, tin? and possibly chromium.

Notwithstanding this specimen comes from the same county with the Burlington iron, still its peculiar physical and chemical properties, leave no doubt of it having formed a totally independent body; and for aught that yet appears, two hundred and seventy-six grains in weight constitutes the totality of the fall!

Appendix to Class I.

a. Grayson county, Virginia.—A meteoric iron is referred to by Prof. J. W. Rogers, as existing in this county, and in which he found 6·15 per cent. of nickel. Vol xliii, p. 169, (1842.)

b. Roanoke county, Virginia.—A meteoric iron is mentioned by Prof. W. B. Rogers as existing in Roanoke county, in which he detected the presence of chlorine. Vol. xliii, p. 169, (1842.)

c. Franconia, New Hampshire.—The following note from Robert Gilmore, Esq. of Baltimore, leads me to believe that a mass of meteoric iron was obtained by this gentleman, ten or twelve years ago in New Hampshire. "It was supposed by Dr. J. F. Dana (late Prof. of Chemistry in Dartmouth College) to be native iron. I purchased it at a village about twelve miles this side of the notch of the White mountains, of a person who told me, that it was found under the roots of a large tree, which was overturned upon the banks of a small stream in his neighborhood. He informed me that the blacksmith who had tried it, found it to be pure iron, and that he had refused to dispose of it to Dr. Dana, who was desirous of purchasing it. I tempted him, however, by a proposal of a higher offer than he had before had made for it, and obtained the mass. The tree, under whose roots it was found, must have been fifty or one hundred years old. I had presented the mass (whose weight was about fifteen pounds) to the Baltimore Academy of Science, in whose keeping it was lost sight of, during the destruction of their building by fire."

(To be continued.)

ART. XI.—*A General Review of the Geological Effects of the Earth's Cooling from a state of Igneous Fusion;* by JAMES D. DANA.

IN former papers in this Journal,* the writer has endeavored to illustrate the origin of many of the earth's features, by reference to the necessary consequences of cooling from a state of igneous fusion. In conclusion, a summary of the results arrived at is here offered, in order to aid the reader in a cautious and comprehensive revision of the subject; for its bearing upon the history of our globe is so important and of so universal a character, that it cannot receive too close attention. If there has been a state of igneous fluidity, the cause appealed to has acted; and to reason rightly on many points in geological dynamics, the effects of this prime cause should be first ascertained. Whatever the fact under consideration, be it an elevation, a subsidence, a fracture, earthquakes, igneous ejections, or any of the like operations or their consequences, we cannot be sure of assigning the true explanation, until it is shown whether this grand agency—which commenced with the very beginning of solidification, to end only with cooling itself,—has operated or not in producing or modifying the result. It is much to be desired that mathematical science may give definiteness to our views on this fundamental point in geological theory.†

The hypothesis of the former fluidity of the earth, we have not deemed it necessary to discuss. The proofs of an approximate uniformity of trend in the earth's features, and consequently of a prevailing structure in the very nature of the crust of our globe, place the question almost, if not quite, beyond doubt. The investigations of W. Hopkins, Esq., showing on astronomical data, that the whole is not now solid, afford still stronger confirmation of the hypothesis, and fully authorize the adoption of it as a basis of reasoning.

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* Vol. ii, ii Ser., p. 335, and iii, 94, 176. 381, 1846, 1847.

† In this branch of investigation, principles of the highest importance to science have already been deduced, with great ability, by W. Hopkins, Esq., F.R.S. We alluded to his researches on the systems of fissures consequent on elevations, in the last volume of this Journal, pp. 395, 396; and we mention here what escaped us till too late for insertion in that place, that his "Researches in Physical Geology," are continued in a series of articles in the Transactions of the Royal Society, for the year 1839, p. 381, for 1840, p. 193, and for 1842, p. 43, treating especially of the bearing of the amount of precession and nutation on the question of the fluidity of the interior of the earth and the thickness of the crust. Mr. Hopkins argues that the earth could not have cooled at the surface as long as there was perfect freedom of motion in the igneous fluid, and concludes that "the minimum thickness of the crust of the globe, which can be deemed consistent with the observed amount of precession, cannot be less than one-fourth of the earth's radius;" also, that the mean inclination of the earth's axis to the place of the ecliptic, can never have changed since solidification commenced.

It should be remarked, that in the following summary the causes alluded to are not presented as the only source of the effects enumerated, though a legitimate and sufficient source. The causes have acted conjointly with the wide-spread agency of water, yet they may have been less dependent on the latter for many results, than has often been urged. We mention no authorities for any of the conclusions stated, as they are already given, as far as known to the author, in the previous articles alluded to.*

General Review of the Consequences of the Earth's Cooling.

I. Solidification of the surface after the fluid material had lost its perfect fluidity.

a. The change inconceivably slow, and hence the rock formed having a coarsely crystalline texture:—the subsequent progress of solidification *beneath* the crust still more gradual, and therefore producing at all periods of the globe a coarsely crystalline texture:—the whole the result of a single immeasurably prolonged operation.†

b. Hence, probably, a general uniformity in the crystalline structure, sufficient to give the crust apparently two directions of easiest fracture, whose mean courses are N.W. b. W. and N.E. b. N.; yet varying much, being probably dependent to a great degree on the early direction of isothermal and isodynamic lines, (this Journal, iii, 392.)

c. In the progress of this cooling, commencing with its first beginning, the surface necessarily presenting large circular or elliptical areas that continued open as centres of fluidity and eruptive action,‡ (ii, 345; iii, 395.) Subsequently, a gradual reduction in size of these centres of igneous action and their frequent extinction.

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* We add here a reference to the valuable memoirs on slaty cleavage, by W. Sharpe, Esq., in the Quart. Jour. Geol. Soc., No. 7, p. 309, and No. 9, pp. 74–105. See also this Journal, last volume, p. 430, and p. 110, in this number.

See also on the effects of cooling, De la Beche's Report on Cornwall, Devon and W. Somerset, 8vo, London, 1839, p. 33, and elsewhere.

† Long sustained heat of a requisite and scarcely varying temperature, is the essential circumstance demanded for the distinct crystallization of most minerals from fusion. It is well known that lava streams after becoming incrusted over, are often years in cooling. Yet they pass to the cold state too rapidly or irregularly, for a coarse crystallization of all the several ingredients of the rock, and thus illustrate the absolute necessity of the condition stated. We have observed elsewhere, that a granite-like structure is seldom produced about a volcanic vent except in its central mass of lavas where they finally cool, shut out from the air by thick beds of non-conducting rock. (ii, 349.)

We remark farther, that a long-continued uniform temperature, of some specific degree, is a condition of the greatest importance in chemical combination. It is a condition which the Author of nature has established in the animal structure, where the most complex compositions take place. And when the requisite degree of heat in specific cases is ascertained, and the means of sustaining an unvarying temperature are at hand, we may predict that some chemical compositions will be made to take place directly, which now require indirect processes. The reason for this is obvious, if we consider that with difference of temperature is connected difference of size, and difference of attracting power both cohesive and chemical.

‡ Well illustrated on the surface of the moon, as also are many of the points here mentioned, (ii, 335.) See Beer and Mädler's charts.

d. A boiling movement or circulation (up at centre and down around the sides) in the vast circular areas of igneous action, owing to escaping vapors, and dependent mainly on the temperature being greatest below at centre and least at the surface and laterally.* As this circulatory or cyclosis movement occurs in material whose mineral ingredients or products differ in the temperature of solidification or of formation, it determines to some extent the distribution of these mineral constituents, and of the rocks which are formed. In later periods, this cause producing a feldspathic centre to volcanic mountains having basaltic sides, (ii, 343.)

e. As refrigeration went on, the centres of eruption becoming mostly extinct over large areas, and remaining still active over other areas of as great or greater extent:—for cooling, wherever commenced, would extend somewhat radiately from the centre where begun, (yet with some relation to the structural lines,) and so gradually enlarge the solidifying area and encroach upon the more igneous portions.

II. Contraction, as a consequence of solidification, attended by a diminution of the earth's oblateness.

a. Rate of contraction in different parts unequal, according to the progress of refrigeration; and after the formation of a crust, greater beneath the crust than in the crust itself, (iii, 96, 181.)

b. Contraction beneath the crust causing a subsidence of the surface.

c. Subsidence greatest where the crust was thinnest or most yielding, and least in those parts which were thickest from having been first stiffened by cooling;—the large areas that continued to abound in igneous action therefore becoming in process of time more depressed than those areas that were early free (or mostly so) from such action, (ii, 352; iii, 181.)

d. Subsidence of the surface progressive; or, if the arched crust resisted subsidence, a cessation, until the tension was such as to cause fractures, and then a more or less abrupt subsiding, (iii, 96.)

e. Frequent changes and oscillations in the water level, either gradual or abrupt, arising from the unequal progress of subsidence in different parts, and also in early periods from extensive igneous action, (iii, 95, 181.)

III. Fissures and displacements of the crust, owing to the contraction below it drawing it down into a smaller and smaller arc; also, from a change in the earth's oblateness.

a. Fissures influenced in direction by the structure of the earth's crust,—because of the existence of such a structure, and also because

* The boiling action in Kilauea, Hawaii, appears in general character, closely like that of boiling water. In the great lake, 1500 feet in diameter, there is an active play of jets over the surface precisely as in a boiling fluid, with no sounds ordinarily but the grum murmur of ebullition. A constant flow is seen in the liquid, (well shown in the jets that move with the current,) from the hottest part, near the northeast side, towards the southwest part of the lake; and this flow is so remarkable that it was formerly accounted for by supposing that a submarine stream of fire here came to the surface, and disappeared again after being for a short distance visible.

the tension causing fractures would be exerted with some reference to the structural lines, the tension and the structure being both a simultaneous consequence of cooling, (iii, 394.)

b. Direction of fissures modified by the relative positions of the large areas of unequal contraction, and whatever the actual course, frequently attended by transverse fractures, (iii, 395, 396.)

c. As the force of tension acts tangentially in a great degree, (like the pressure of stone against stone in an arch, and that of the whole arch against the supporting or confining abutments,) the effects will appear either over the subsiding area, or on its borders; and they will be confined to the latter position whenever the surface is strong enough to resist fracture, (iii, 96, 97, 181, 395.)

d. The borders of large subsiding areas sooner or later experiencing deep fissurings and extensive upliftings through the tension or horizontal force of the subsiding crust; these upliftings frequently in parallel series, of successive formation, or constituting a series of immense parallel folds; *that* side of the fold in general steepest which is most remote from the subsiding area, (iii, 98, 182, 186.)

e. Fissures formed having the character of a series of linear rents either in interrupted lines or parallel ranges, instead of being single unbroken lines of great length, and this owing to the brittle nature and structure of the earth's crust; ranges sometimes curved, either from having a general conformity to the outlines of contracting areas, or because proceeding from an inequality of force along parallel lines of tension over a subsiding area,* (iii, 185, 385.)

IV. Escape of heat and eruptions of melted matter from below through opened fissures.

a. Igneous ejection of dikes an *effect* and not a cause of displacements, (iii, 99, 185.)

b. Some points in the wider fissures continuing open as vents of eruption. The outlines of large contracting areas being liable from the cause just stated to deep fissurings, these therefore likely to abound most in volcanic vents, (iii, 98, 186.)

c. Heat from many fissures giving origin to hot springs.

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* The writer would remark here, in order not to be misunderstood, that in accounting for curving ranges of elevations, or courses of fissures, by the lateral force of a subsiding crust, (iii, 395,) he has considered the smaller circular areas of igneous action alluded to, as producing scarcely appreciable results, except when combined in large compound areas which subside as a whole. The great curves on the east and northeast of Asia, in the mountains of the continent, as well as in the ranges of islands, are not necessarily due to each being the outline of a circular area of contraction, although we cannot deny that instances of this are possible; but rather to the subsidence that deepened the Pacific depression, and its unequal amount in different transverse lines, connected with the structural character of the crust or its courses of easiest fracture, (iii, 185:)—for these curves are all *convex* alike *towards the ocean*, and similar also are the subordinate curves in the East Indies, (such as that by Negros, West Mindanao and the Sooloo Sea to North Borneo, and that by East Mindanao, Sangir and North Celebes,) as well as the curves in the mountains of Eastern Australia, (iii, 388.)

d. Distribution of the heat attending submarine action, causing metamorphic changes.*

V. Earthquakes, or a vibration of the earth's crust, consequent on a rupture, internal or external, and causing vibrations of the sea besides other effects, (iii, 181.)

VI. Epochs in geological history, (iii, 187.)

VII. Courses of mountains and coast lines, and general form of continents, determined to a great extent by the general direction of the earth's cleavage structure, and the position of the large areas of greatest contraction.

Continents (or areas of comparatively slight contraction) often therefore present ranges of mountains near their borders, and these mountains are highest and abound most in volcanoes around the *largest* ocean, (the Pacific, iii, 398.) Thus the existence of such continental areas determined the existence of the mountains they contain; and also the mountains in their turn, determined to some extent the position and nature of subsequent deposits formed around them, effecting this either directly, or by influencing the courses of ocean currents during partial or entire submergences, or by determining the outlines of ancient seas of different epochs. According to this view, the general forms of continents, and those of the seas, however modified afterward, were to a great extent fixed in the earliest periods by the condition and nature of the earth's crust. They have had their laws of growth, involving consequent features, as much as organic structures. In this remark, we refer not, under the term continent, to the surfaces of land bounded by the water line; for these, by slight subsidences, are greatly varied in form and size:—but to those extended areas, which, were there no water, would stand raised far above the intermediate oceanic depressions.

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* In this Journal, Vol. xlv, p. 111, (1843,) the writer has supported the principle that metamorphic changes require no other cause but what attends submarine igneous action, and that the word *hypogene* applied to such rocks is inadmissible. The views there presented properly include not only the heat from submarine volcanic action and fissure ejections, but that escape of heat, going on for ages, through the fractures attending the gradual folding and uplifting of strata while beneath the sea. Similar views, of earlier date, are offered by De la Beche, in his very able Report on Cornwall, Devon and W. Somerset, 8vo, 1839. The de-bituminization of the anthracite coal of the Appalachians appears to be attributed by Prof. Rogers essentially to this cause. (Trans. Assoc. Amer. Geol. and Nat., 1840–1842, p. 473.)

Art. XII.—*Review of the Organic Chemistry of* M. Charles Gerhardt.*

This book appeals with peculiar claims to the notice of all interested in the progress of chemical science. Organic chemistry has made great progress during the last few years; but until the publication of the Précis, with the exception of Liebig's excellent Traité de Chimie Organique, no systematic work embracing the results of the last decade had appeared. This is to be ascribed to the great difficulty of classifying the immense array of facts, and harmonizing the various conflicting theories—a task indispensable as a preparation for such a work and at the same time exceedingly delicate.

Liebig in his Traité assumed as the basis of his system, the theory of compound radicals, and commences with the assertion, that "organic chemistry is the chemistry of compound radicals." This was a most ingenious application of the electrochemical philosophy of Berzelius to the investigation of this class of compounds, and was supported by so many analogies as to render it very probable; at the same time it admitted the application of the received nomenclature to these bodies. These radicals are generally however purely hypothetical, and when we are able to isolate substances having the composition assigned to them, they are found to possess none of the properties which theory would require. Recent experiments have shown that mellon and mellonids have not the composition ascribed to them by Liebig, and that mellon cannot be regarded as a compound radical. Cyanogen and kakodyle must however be excepted, as compounds which comport themselves in many respects like elementary bodies.

The progress of discovery has shown, that this hypothesis is but poorly adapted to form the basis of a system of classification, for the discovery of nearly every new body requires the assumption of an imaginary compound to explain its reactions in accordance with the theory of radicals; and so uncertain are the principles which are to direct us in the application of this theory, that different chemists often assign very different *rational formulas* to the same compound. There have been not less than seven different formulas proposed, to express the arrangement of the elements in alcohol; each author seeking by his own to explain some practical relation. Thus Dumas regards it as the bi-hydrate of olefiant gas; Liebig as the hydrated protoxyd of ethyle,

* Précis de Chimie Organique; par M. Charles Gerhardt, Professeur à la Faculté des Sciences de Montpellier. 2 vols. 8vo. Paris, (Fortin, Masson et Cie.) 1845.—We are indebted for this review and abstract of M. Gerhardt's valuable work, to Mr. Thomas S. Hunt, lately from the Laboratory of Yale College, and now Chemist to the geological survey of the Canadas.

C_4H_5; Berzelius as the bin-oxyd of C_4H_6, and Zeise as a hydruret of $C_4H_5O_2$. The inconvenience of this system arises not only from the fact that the radicals are hypothetical, but that their very existence in the compounds is alternately claimed and denied, and the elements are arranged and re-arranged like the letters in an anagram, as the case may require. M. Liebig seems to have felt its deficiencies, for after describing in the first volume of his Traité, a number of bodies as derivatives of compound radicals, in the succeeding portions of the work he returns to the old divisions of acids, alkalies, essential oils, etc.

This mode of viewing organic compounds resulted from the idea of dualism in chemical compositions, which had found advocates in the great majority of chemists since the days of Lavoisier, and has been perpetuated by the received system of nomenclature. And although there have been at different times those who have seen the difficulties of the binary system, it is only within a few years that a different philosophy has gained partisans.* This new system is distinguished as that of the *French school*, and ranks among its adherents the most distinguished chemists of France. It rejects entirely the idea of a binary arrangement in the composition of bodies, and regards their atoms as constituting a system, in which one or more molecules may be exchanged for others without altering the chemical constitution or type of the arrangement.

M. Gerhardt, who has been long known as one of the most distinguished chemists of France, has attempted the task of systematizing the great accumulation of facts which organic chemistry presents, and framing a classification that shall embrace all those substances whose composition is accurately determined, and in the present work he has given us the result of his labors.

Researches in organic chemistry have shown that we can produce artificially many products of the vegetable and animal organisms. Thus sugar yields by different processes, butyric, oxalic and formic acids; the first of these is one of the acids of butter, the second exists in the fluids of many plants, the last is a secretion of ants. Again bee's wax, when fused with caustic potash, forms stearic acid, one of the acids of animal tallow; by the action of nitric acid, it yields a number of new compounds among which is succinic acid, which exists in amber. These products are less complex in their constitution than the original substances; sugar by the action of oxydizing agents yields, besides formic acid, carbonic acid gas and water, and wax when converted into succinic acid, undergoes a similar decomposition.

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* Mr. J. D. Whelpley attempted some years since, to show from the electro-chemical decomposition of the metallic salts of the mineral acids, that they must be regarded not as binary compounds of an acid with an oxyd, but as ternary combinations of the metal, oxygen, and the other element. This principle was made by him the basis of a beautiful and ingenious classification of all saline compounds.

We cannot retrace this process and bringing together the formic acid, carbonic acid and water, by a process of dexoydation reproduce the sugar. These products were formed by a combustion in which a part of the carbon and hydrogen is converted into carbonic acid and water, and the power of reducing them belongs to the vegetable organism, where the chemical affinities are controlled and directed in a peculiar way by the vital force. It is thus that in these operations, we commence with a complex body and by a process in which its carbon and hydrogen are gradually oxydized, reduce it to simpler and simpler forms.

There are however some exceptions to this law; a few synthetical processes are known by which we can unite the elements of simpler compounds to form one more complex. Two polymeric bodies are known which are formed by a grouping together of several molecules of aldehyde; and many of the essential oils undergo a similar change by action of sulphuric acid. The decomposition of organic substances by heat offers some remarkable instances of this kind; in the dry distillation of wax $C_{19}H_{38}O$, we obtain paraffine, which is $C_{24}H_{50}$.

In view of these relations, observes our author, "we may consider all organic substances as the result of the combustion of others more rich in carbon and hydrogen, or reciprocally as the products of the reduction or complication of other bodies containing less carbon and hydrogen."

"In considering from this point of view the whole of organic substances, we observe that they offer successive and almost insensible gradations, in such a manner as *to form an immense scale*, the two extremities of which are occupied, the one at the summit, by the cerebral substance, albumen, fibrine and other bodies still more complex; and on the other at the bottom by carbonic acid, water and ammonia, preceded by wood-spirit with formic acid and the other bodies derived from it."

"The chemist in applying the agents of combustion to substances, *descends the scale*, that is to say, he gradually simplifies these substances by burning successively, portions of their carbon and hydrogen. On the contrary, *he remounts the scale* in applying to organic substances the processes of reduction. These considerations conduct us to an exact appreciation of the principles upon which we may classify all organic substances in a simple and complete manner, which does not have recourse to hypothesis, but confines itself strictly to the limits of experience." pp. 21, 22.

In the examination of organic substances, we observe that those which correspond in their chemical characteristics, present a similarity of relation in the proportions of their constituent elements. The alcohols, embracing wood-spirit, spirit of wine,

potato-oil and ethal, are examples; their composition is respectively CH_4O_2, C_2H_6O, $C_5H_{12}O$ and $C_{16}H_{34}O$.*

If the single equivalent of oxygen which each of them contains, were united with two equivalents of the hydrogen to form water, the carbon and hydrogen in the residue of each would be in the proportion of 1 to 2. By oxydizing agents the alcohols lose two equivalents of hydrogen and gain one of oxygen, giving rise to the formic, acetic, valerianic and ethalic acids, in each of which the carbon and hydrogen are in the proportion of one to two; and in all the products of the transformation of these bodies, the proportions of these elements still bear a similar relation to each other. Hence if we know the composition of any derivative of spirit of wine, we can at once foresee that of a similar product derived from any other body of the group.

Substances like these having a likeness in characters depending upon a similarity of constitution are denominated *homologues;* and are to be carefully distinguished from those which resemble each other merely in physical characters, and which are called *analogues.* For example, wood-spirit resembles acetone in being inflammable, odorous, very volatile, and soluble in water, while ethal is allied to stearine in being solid at ordinary temperatures, insoluble in water and having other properties common to the fatty bodies; but their resemblances are only analogies, and when we examine wood-spirit and ethal in relation to their constitution and the products of their decomposition, we find that they are closely related to each other and are homologues.

In homologous bodies, the combustible elements, carbon and hydrogen vary exceedingly in their proportions, while the oxygen and azote are always atomically the same. Two bodies therefore which contain the one O_2 and the other O_3, or one N and the other N_2, cannot be homologues, while bodies containing C_2, or C_5 and H_{12} or H_{34}, may very well be so, as in the alcohols already mentioned. M. Gerhardt has adopted some general formulas to express these relations; R, representing the carburets of hydrogen; RO, those bodies which like alcohol, contain one equivalent of oxygen; while other oxygenized compounds are designated as RO_2, RO_3, &c. Those containing nitrogen are represented in a similar manner, thus RN, RN_2O_3.

In order that two or more bodies may be homologues, it is not sufficient that they can be represented by the same general formula; the equivalent ratio between the proportions of carbon and hydrogen must also be identical. Formic acid CH_2O_2, acetic acid $C_2H_4O_2$, valerianic acid $C_5H_{10}O_2$, and ethalic acid $C_{16}H_{32}O_2$ are designated by the general formula RO_2, and in

* In these formulas it will be observed that our author divides the equivalent of hydrogen, representing water by H_2O. The equivalent of most of organic compounds is taken at one-half the number usually adopted, for reasons which will be explained farther on.

each of them R represents a compound in which the carbon and hydrogen are in the proportion of 1 : 2. These bodies are homologues, and the relation of their elements is such that they may evidently be derived from each other by the abstraction of equal equivalents of carbonic acid CO_2 and water H_2O. This is then the most simple ratio, and is selected as the term of comparison. It is not however the most frequent; generally the hydrogen is less than two, and when it exceeds it, the excess is seldom more than two equivalents.

"When homologous bodies are decomposed into other homologues, they lose or fix atomically the same quantities of carbonic acid, water, oxygen, &c." This principle is illustrated by the group of alcohols so often referred to; when converted into hydrocarbons, they give up one equivalent of water, and in the formation of acids they severally lose H_2 and fix O. From this it follows that a geometrical ratio between the elements of homologous substances is not necessary; bodies having the following proportions of C and H may be homologues:

C	H		C	H
1 :	4 =	1 : (2 + 2)	4 :	4 = 4 : (8 − 4)
2 :	6 =	2 : (4 + 2)	6 :	8 = 6 : (12 − 4)
5 :	12 =	5 : (10 + 2)	8 :	12 = 8 : (16 − 4)
16 :	34 =	16 : (32 + 2)	16 :	28 = 16 : (32 − 4)

and the same principle applies to any other proportions of these elements. In the first group, each compound by losing in equivalents of hydrogen is reduced to the normal ratio, and in the second, the addition of four is required.

To express these relations, the symbol R is preserved for the ratio of 1 : 2; for those bodies in which the proportion of hydrogen is greater, the number of equivalents is indicated by an exponent preceded by the sign plus (+), and when its proportion is less it is expressed by a similar exponent with the sign minus (−).

Wood-spirit CH_2O, alcohol C_2H_6O, potato-oil $C_5H_{12}O$ and ethal $C_{16}H_{34}O$, are by this notation, homologues of the form $R^{+2}O$, and the acids derived from them by the abstraction of two equivalents of hydrogen and the addition of one of oxygen are expressed by the formula RO_2. The acids, oxalic $C_2H_2O_4$, succinic $C_4H_6O_4$, pimelic $C_7H_{12}O_4$ and suberic $C_8H_{14}O_4$ are homologues of the form $R^{-2}O_4$; oxamid $C_2H_4N_2O_2$ and succinamid $C_4H_8N_2O_2$, are homologous bodies of the form RN_2O_2; benzene C_6H_6 and cumene C_9H_{12} are expressed by R^{-6}, and so on. To determine whether two bodies having the same amount of oxygen, can be homologues, we assume a number of equivalents of hydrogen equal to twice that of the carbon, (this being the proportion of 1 : 2,) and observe whether the excess or deficiency of hydrogen is the same in both; and consequently whether they can be expressed by the same formula.

The salicylic acid $C_7H_6O_3$, and the anisic $C_8H_8O_3$, are monobasic and contain three equivalents of oxygen; in the first, the deficiency of hydrogen is $14-6=8$, and the second $=16-8=8$. These acids may then be represented by the formula $R^{-8}O_3$.

This proportion between the elements of a compound does not, however, necessarily imply a homology; there are some exceptions which depend in some way upon the peculiar grouping of the elements. Thus ordinary ether $C_4H_{10}O$, is represented by the same general formula as alcohol $R^{+2}O$, but the chemical characters of the two are entirely different and do not allow us to consider them homologues. It is then necessary to add as a condition of homology, a similarity of chemical characters, dependent upon a like arrangement of the molecules. Vol. i, pp. 29–35.

This notation expresses in a beautiful and simple manner, the relations of homology which exist between different compounds. It is the peculiarity of this system that it is based upon the natural affinities of bodies and not upon analogies; this is the only arrangement which will always be correct, because it is founded in the constitution of the substances themselves.

The important relations which the combustible elements sustain, appear "to permit us to class homologous bodies according to their carbon," and M. Gerhardt has accordingly constructed upon this basis a classification in which all organic substances are arranged in a tabular form. Those containing the same atomical proportion of carbon constitute a family which is designated by the number of equivalents of that substance. Each family is divided into the carburets of hydrogen and those containing oxygen and nitrogen, so that we have R, RO_2, RN, &c. These divisions are found on the left of the table, while at the top are marked at the head of their respective columns, the proportions of hydrogen. This will be better understood by a view of a part of the 1st and 2d families.

Family.	Gen. formula.	R^{+2}	R	R^{-2}
2.	R	C_2H_6, acetene.	C_2H_4, olefiant gas.	
	RO	C_2H_6O, (*a*) alcohol. (*b*) metl. ether.	C_2H_4O, aldehyde.	
	RO_2	. . . .	$C_2H_4O_2$, acetic acid.	
	RO_4	. . . .	. . .	$C_2H_2O_4$, oxalic acid.
1.	R	CH_4, marsh gas.		
	RO	CH_4O, wood-spirit.	. . .	CO, oxyd of carbon.
	RO_2	. . . .	CH_2O_2, formic acid.	CO_2, carbonic acid gas.

By this arrangement we are able at once to give a new substance a place, and to determine its relation to other series of compounds; those bodies which are homologues are always found in the same vertical column, and hence in looking over the table, we see at once in what families homologues of any particular form exist, and how these may be formed from other bodies of the same family. This may be illustrated by an extensive class of homologous acids of the form RO_2, which are here given with their families and formulas.

1.	Formic,	C	H_2	O_2	11.	
2.	Acetic,	C_2	H_4	O_2	12. Lauric,	$C_{12}H_{24}O_2$
3.	Metacetonic,	C_3	H_6	O_2	13. Cocinic,	$C_{13}H_{26}O_2$
4.	Butyric,	C_4	H_8	O_2	14. Myristic,	$C_{14}H_{28}O_2$
5.	Valerianic,	C_5	H_{10}	O_2	15.	
6.	Caproic,	C_6	H_{12}	O_2	16. Ethalic,	$C_{16}H_{32}O_2$
7.	Enanthylic,	C_7	H_{14}	O_2	17. Margaric,	$C_{17}H_{34}O_2$
8.	Caprylic,	C_8	H_{16}	O_2	18. Anamiritic,	$C_{18}H_{36}O_2$
9.	Pelargonic,	C_9	H_{18}	O_2	19. Stearic,	$C_{19}H_{38}O_2$
10.	Capric,	C_{10}	H_{20}	O_2		

The acids of the 1st, 2d, 5th, and 16th families are derived directly from alcohols of the formula $R^{+2}O$; and in the 2d we find aldehyde C_2H_4O, a derivative of alcohol, which fixes one equivalent of oxygen to form the acid. Spermaceti in the 16th family has the formula $C_{16}H_{32}O$, and forms ethalic acid by combining with an equivalent of oxygen; it is consequently a homologue of aldehyde. No homologues of alcohol are known in the other families; but in butyral C_4H_8O, and beeswax $C_{19}H_{38}O$, we have bodies corresponding to aldehyde, and enanthole and menthol are probably the aldehydes of the 7th and 10th families. We may anticipate that future researches will discover an aldehyde and alcohol for each of these acids, and fill up the 11th and 15th families by a similar series. Four acids of this group have been added to the list within the last two years,* and butyral was but recently discovered as a product of the destructive distillation of butyrate of lime. It will be remembered that ethal, an alcohol, is formed by the action of potash upon spermaceti its corresponding aldehyde. We can thus obtain aldehydes from alcohols and acids, and alcohols from aldehydes.

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* They are, the metacetonic, discovered by Gottlieb; the enanthylic or azoleic, which was formerly considered as a bibasic acid; and the pelargonic, observed by Redtenbacher among the products of the oxydation of oleic, and supposed to be identical with the acid of the *pelargonium roseum*. This occupies the place formerly assigned to the copsic acid of Chevreul, which the observations of Lerch have shown to be a mixture of capric with a new acid, the caprylic.

The salicylic acid $C_7H_6O_3$, and the anisic $C_8H_8O_3$, are monobasic and contain three equivalents of oxygen; in the first, the deficiency of hydrogen is $14-6=8$, and the second $=16-8=8$. These acids may then be represented by the formula $R^{-8}O_3$.

This proportion between the elements of a compound does not, however, necessarily imply a homology; there are some exceptions which depend in some way upon the peculiar grouping of the elements. Thus ordinary ether $C_4H_{10}O$, is represented by the same general formula as alcohol $R^{+2}O$, but the chemical characters of the two are entirely different and do not allow us to consider them homologues. It is then necessary to add as a condition of homology, a similarity of chemical characters, dependent upon a like arrangement of the molecules. Vol. i, pp. 29–35.

This notation expresses in a beautiful and simple manner, the relations of homology which exist between different compounds. It is the peculiarity of this system that it is based upon the natural affinities of bodies and not upon analogies; this is the only arrangement which will always be correct, because it is founded in the constitution of the substances themselves.

The important relations which the combustible elements sustain, appear "to permit us to class homologous bodies according to their carbon," and M. Gerhardt has accordingly constructed upon this basis a classification in which all organic substances are arranged in a tabular form. Those containing the same atomical proportion of carbon constitute a family which is designated by the number of equivalents of that substance. Each family is divided into the carburets of hydrogen and those containing oxygen and nitrogen, so that we have R, RO_2, RN, &c. These divisions are found on the left of the table, while at the top are marked at the head of their respective columns, the proportions of hydrogen. This will be better understood by a view of a part of the 1st and 2d families.

Family.	Gen. formula.	R^{+2}	R	R^{-2}
2.	R	C_2H_6, acetene.	C_2H_4, olefiant gas.	
	RO	C_2H_6O, (*a*) alcohol. (*b*) metl. ether.	C_2H_4O, aldehyde.	
	RO_2	. . . .	$C_2H_4O_2$, acetic acid.	
	RO_4	. . . .	. . .	$C_2H_2O_4$, oxalic acid.
1.	R	CH_4, marsh gas.		
	RO	CH_4O, wood-spirit.	. . .	CO, oxyd of carbon.
	RO_2	. . . .	CH_2O_2, formic acid.	CO_2, carbonic acid gas.

By this arrangement we are able at once to give a new substance a place, and to determine its relation to other series of compounds; those bodies which are homologues are always found in the same vertical column, and hence in looking over the table, we see at once in what families homologues of any particular form exist, and how these may be formed from other bodies of the same family. This may be illustrated by an extensive class of homologous acids of the form RO_2, which are here given with their families and formulas.

1.	Formic,	C	H_2	O_2	11.	
2.	Acetic,	C_2	H_4	O_2	12. Lauric,	$C_{12}H_{24}O_2$
3.	Metacetonic,	C_3	H_6	O_2	13. Cocinic,	$C_{13}H_{26}O_2$
4.	Butyric,	C_4	H_8	O_2	14. Myristic,	$C_{14}H_{28}O_2$
5.	Valerianic,	C_5	H_{10}	O_2	15.	
6.	Caproic,	C_6	H_{12}	O_2	16. Ethalic,	$C_{16}H_{32}O_2$
7.	Enanthylic,	C_7	H_{14}	O_2	17. Margaric,	$C_{17}H_{34}O_2$
8.	Caprylic,	C_8	H_{16}	O_2	18. Anamiritic,	$C_{18}H_{36}O_2$
9.	Pelargonic,	C_9	H_{18}	O_2	19. Stearic,	$C_{19}H_{38}O_2$
10.	Capric,	C_{10}	H_{20}	O_2		

The acids of the 1st, 2d, 5th, and 16th families are derived directly from alcohols of the formula $R^{+2}O$; and in the 2d we find aldehyde C_2H_4O, a derivative of alcohol, which fixes one equivalent of oxygen to form the acid. Spermaceti in the 16th family has the formula $C_{16}H_{32}O$, and forms ethalic acid by combining with an equivalent of oxygen; it is consequently a homologue of aldehyde. No homologues of alcohol are known in the other families; but in butyral C_4H_8O, and beeswax $C_{19}H_{32}O$, we have bodies corresponding to aldehyde, and enanthole and menthol are probably the aldehydes of the 7th and 10th families. We may anticipate that future researches will discover an aldehyde and alcohol for each of these acids, and fill up the 11th and 15th families by a similar series. Four acids of this group have been added to the list within the last two years,* and butyral was but recently discovered as a product of the destructive distillation of butyrate of lime. It will be remembered that ethal, an alcohol, is formed by the action of potash upon spermaceti its corresponding aldehyde. We can thus obtain aldehydes from alcohols and acids, and alcohols from aldehydes.

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In this series we observe a regular gradation from the volatile and soluble formic and acetic acids to the solid fatty acids at the other extremity of the scale. Those from the 4th to the 10th inclusive are oily and sparingly soluble, and present a regular increase of about 20° Centigrade in their boiling points; higher in the scale they are solid at the ordinary temperature, and the stearic and margaric cannot be distilled without decomposition. Redtenbacher has recently shown that all the liquid acids of this group, with the exception of the formics, are produced in the oxydation of oleic acid by nitric acid.* Stearic acid by the action of the nitric loses two equivalents of carbon and four of hydrogen in the form of water and carbonic acid; and yields the margaric; which by a farther oxydation affords several of the volatile acids of the series. The other solid acids yield the same results, and are perhaps intermediate products in the oxydation of the margaric by nitric acid.

By the action of nitric acid upon wax, we oxydize a portion of its carbon and hydrogen, and obtain a series of bodies lower in the scale; among these are the succinic, pimelic, and suberic acids, which, as we have already seen, are homologues of the form $R^{-2} O_4$. Spermaceti yields the same products as wax, but if we expose its homologue of the 2d family, aldehyde, to this process, it cannot yield succinic acid, which belongs to the 4th family, but we obtain instead its homologue in the 2d family, oxalic acid.

The results of science are continually demonstrating the universality of the maxim of Linnæus, *Natura non facit saltum.* We see bodies possessing the most dissimilar physical characters, but agreeing in constitution, when arranged according to their chemical relations exhibiting such a gradation that it is difficult to say where the seeming dissimilarity begins or ends, and we may expect that future discoveries will show many bodies of which but one or two homologues are now known to be members of a complete series.

The examples which we have given, will illustrate the features of this classification; which founded as it is upon the natural affinities of bodies and the numerical relations of their elements, must necessarily be permanent.

(*To be continued.*)

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* This Journal, ii Ser., Vol. iii, No. 8.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *Congelation of Mercury in three seconds, by virtue of the spheroidal state, in an incandescent crucible*, (Letter from M. Faraday to Boutigny, Ann. de Chim. et de Phys., xix, May, 1847, p. 383.)—In producing congelation of mercury by virtue of the spheroidal state, I first heated a crucible to redness and maintained it at this temperature; I then introduced some ether, and then solid carbonic acid; into this mixture in a spheroidal state, I inserted a metallic capsule containing about 31 grammes of mercury, and in two or three seconds it was solidified. It seemed strange indeed that mercury put into a red hot crucible should come out congealed.

2. *On a new Test for Prussic Acid, and on a simple Method of preparing the Sulphocyanid of Ammonium;* by Prof. Liebig, (Liebig's Annalen, Jan., 1847; Chem. Gaz., April, 1847.)—When some sulphuret of ammonium and caustic ammonia are added to a concentrated aqueous solution of prussic acid, and the mixture heated with the addition of pure flowers of sulphur, the prussic acid is converted in a few minutes into sulphocyanid of ammonium. This metamorphosis depends on the circumstance, that the higher sulphurets of ammonium are instantly deprived by the cyanid of ammonium of the excess of sulphur they contain above the monosulphuret; for instance, if a mixture of prussic acid and ammonia be added to the pentasulphuret of ammonium, the solution of which is of a deep yellow color, and the whole gently heated, the sulphuret of ammonium is soon decolorized; and when the clear colorless liquid is evaporated, and the admixture of sulphuret of ammonium expelled, a white saline mass is obtained which dissolves entirely in alcohol. The solution yields, on cooling or evaporation, colorless crystals of pure sulphocyanid of ammonium. Only a small quantity of sulphuret of ammonium is requisite to convert, in the presence of an excess of sulphur, unlimited quantities of cyanid of ammonium into sulphocyanid; because the sulphuret of ammonium, when reduced to the state of monosulphuret, constantly reacquires its powers of dissolving sulphur and transferring it to the cyanid of ammonium. The following proportions will be found to be advantageous:—2 oz. of solution of caustic ammonia of 0·95 spec. grav. are saturated with sulphuretted hydrogen gas; the hydrosulphuret of ammonium thus obtained is mixed with 6 oz. of the same solution of ammonia, and to this mixture 2 oz. of flowers of sulphur are added; and then the product resulting from the distillation of 6 oz. prussiate of potash, 3 oz. of the hydrate of sulphuric acid, and 18 oz. water. This mixture is digested in the water-bath until the sulphur is seen to be no longer altered and the liquid has assumed a yellow color; it is then heated to boiling, and kept at this temperature until the sulphuret of ammonium has been expelled and the liquid has again become colorless. The deposited, or excess of, sulphur is now removed by filtration, and the liquid evaporated to crystallization. In this way from $3\frac{1}{3}$ to $3\frac{1}{2}$ oz.

of dazzling white dry sulphocyanid of ammonium are obtained, which may be employed as a reagent, and for the same purpose as the sulphocyanid of potassium. Of the 2 oz. of sulphur added, $\frac{1}{2}$ an oz. is left undissolved.

The behavior of the higher sulphurets of ammonium towards prussic acid furnishes an admirable test for this acid. A couple of drops of a prussic acid, which has been diluted with so much water that it no longer gives any certain reaction with salts of iron by the formation of prussian blue, when mixed with a drop of sulphuret of ammonium and heated upon a watch-glass until the mixture is become colorless, yields a liquid containing sulphocyanid of ammonium, which produces with persalts of iron a very deep blood-red color, and with persalts of copper, in the presence of sulphurous acid, a perceptible white precipitate of the sulphocyanid of copper.

3. *Separation of Alumina from Oxyd of Iron.*—Dr. W. Kuop (Jour. für Prakt. Chem., Oct. 9, 1846,) states that he has effected a complete separation of these two oxyds by precipitating with sulphuret of ammonium, washing the precipitate with water containing a little free sulphuret of ammonium, and then extracting the alumina by a solution of potash which also must have a little sulphuret of ammonium in it. In this way the alumina, on subsequent precipitation, is obtained on slow desiccation as a transparent mass, and on quickly drying and calcining it has so perfectly a white color as to leave no doubt of its being extremely pure.

4. *Detection of minute traces of Alcohol;* (Monthly Jour. Med. Sci., Dec., 1846.)—Dr. R. D. Thomson proposes in place of the distillation of a liquid suspected to contain alcohol, and trusting to the odor of alcohol in the product, which is the usual mode, to resort to the use of chromic acid, which as is well known, produces a characteristic emerald green solution of oxyd of chromium, in fluids containing alcohol. The characteristic odor of aldehyde given off from the dehydrogenation of the alcohol by the chromic acid, also aids materially in detecting minute quantities of spirits of wine. For this purpose a small quantity of bichromate of potash is placed in the bottom of a conical glass containing a portion of the suspected fluid, and sulphuric acid is poured on it by means of a tube funnel. If alcohol is present, the green oxyd will soon be observed on the surface of the undissolved salt, and the characteristic odor of aldehyde will speedily be perceptible.

5. *On the Acid Reaction of the Gastric Juice;* by Prof. C. G. Lehmann, (Bericht der Gesellschaft der Wissenschaften in Leipzig, p. 100–105; Chem. Gaz., March, 1847.)—Pelouze, and especially Bernard and Barreswil, have shown with certainty the absence of free muriatic acid in the gastric juice. The author has obtained the same result, and at the same time he has indisputably proved the presence of free lactic acid. To obtain the gastric juice of dogs in the greatest state of purity possible, these animals were kept without food for from twelve to sixteen hours, and then fed from ten to twenty-five minutes before death with bones freed as perfectly as possible from skin and fat. Immediately after they were killed, the stomach was tied at the cardia and pylorus, and removed from the body. It was then opened by an oblique incision near the pylorus, and the fluid poured out, without the stomach being at

the same time much moved. The gastric juice thus obtained was almost perfectly clear, scarcely opalescent. The stomach of a dog of the size of a poodle contained from fifteen to forty grms. of a liquid, which flowed out spontaneously; that of a large pointer, from thirty to ninety grms. The fresh gastric juice was poured into a shallow broad flask, the mouth of which was closed by a cork, and through this, a glass tube, bent four times at a right angle, was passed; the latter was covered with nitrate of silver on its inner side. The apparatus was placed under the air-pump with dry hydrate of potash, and exhaustion then applied. When the gastric juice had been evaporated until it was of a syrupy consistence, vapors of muriatic acid were evolved somewhat suddenly, so that the chlorid of silver formed could be determined qualitatively and quantitatively. Treated in this manner, a gastric juice which was but slightly opalescent for instance, yielded 1·808 per cent. of solid residue, 0·125 per cent. muriatic acid, and 98·067 per cent. of water. This muriatic acid is formed by the decomposing action of the lactic acid at a certain degree of concentration, even in the cold, upon many chlorids, especially those of calcium and magnesium, but not the chlorids of potassium and sodium. To prove the presence of the lactic acid itself with certainty, the gastric juice was concentrated *in vacuo* to one-twelfth its volume, the residue mixed with alcohol of 0·85 spec. grav., the spirituous solutions from several stomachs evaporated to the consistence of a syrup, and the residue exhausted with absolute alcohol. The residue of this was exhausted with ether, and the ethereal extract mixed with water to remove the fat, and filtered. On further concentration, more drops of oil separated from the filtrate; moreover, the fluid about to be tested still contained muriate of ammonia. The liquid was partly saturated with lime, partly with magnesia, and the salts formed were purified by several recrystallizations from alcohol and water. The magnesian salt, dried at 266° F., and then incinerated, gave 16·666 per cent. of magnesia, 61·906 per cent. lactic acid, and 21·428 per cent. water; the formula MgO, $\overline{La}$+3HO requires 16·085 per cent. magnesia, 62·936 per cent. lactic acid, and 20·979 per cent. water. In some other experiments, fasting dogs were fed from twenty to forty-five minutes before death with horse-flesh containing but little fat. The fluid which flowed spontaneously from the stomach, when filtered, left 5·602 per cent. of residue, and thus contained nutritive matters already in solution, which were detected by the copious precipitate produced by alcohol, or the formation of yellowish-brown films on evaporation. The gastric fluid thus obtained yielded no muriatic acid under the air-pump. From this fluid a magnesian salt was also obtained. I. gave 16·666 per cent. of magnesia, 62·122 $\overline{La}$, and 21·212 HO; II., which was obtained by exhausting the contents of the stomach with water, gave 15·966 per cent. MgO, 62·026 $\overline{La}$, and 21·008 per cent. of HO.

6. *Equivalent number of Titanium*, (L'Institut, March 10, 1847.)—The equivalent of titanium has been determined from the bichlorid of titanium by M. Isidore Pierre, Professor at Bordeaux. He obtained, in a series of five experiments, the numbers 314·76, 314·37, 314·94, 311·84, 309·88; in a second series, 313·41, 311·30, and in a third 311·58, 309·41. Operating with the greatest care, some small pro-

portion of the chlorid is supposed to decompose during the experiment, through the humidity of the air; and in this way M. Pierre accounts for the variation in the above results. Believing that the first three results are most correct, he adopts the number 314·69 (or on the hydrogen scale, 25·13) for the equivalent.

7. *On the compounds of Iron with Carbon;* by M. KARSTEN, (Bericht Berlin Akad., Nov. 5, 1846; Chem. Gaz., March, 1847.)—The determination of the amount of carbon in the different kinds of bar iron, steel and pig iron, are still variable and uncertain, partly owing to the estimation of the amount of carbon being very tedious if not difficult, and partly because the limits between bar iron and steel, as well as between steel and pig iron, are wholly undetermined, and are merely assumed conventionally from certain physical properties of the product. Combinations in definite proportions between iron and carbon are not to be met with in the carburets of iron; for the union of these two substances takes place in indefinite proportions, uninterruptedly, from 0 to the maximum amount of carbon, which is about 5·93 per cent. The classification of the carburets of iron in three divisions, bar iron, steel, and pig iron, is consequently not necessary, i. e., not required, by the combining proportions, but wholly arbitrary.

To determine the amount of carbon, the best methods of separating the carbon from iron were employed; but in order to ascertain the degree of trust-worthiness belonging to each, white pig iron, with a bright metallic surface, smelted with charcoal from sparry iron ore at the Sayner works near Bendorf on the Rhine, was submitted to experiment. This pig iron contains no uncombined carbon (graphite), or at least but mere traces; and the amount of combined carbon approaches closely to the maximum amount which iron is capable of taking up.

The amount of carbon of this pig iron was found, by different methods of analysis, as follows:—

	Per cent.
By elementary analysis with oxyd of copper, the carbon being calculated from the carbonic acid gas,	4·2835
By elementary analysis with chlorate of potash and chromate of lead,	5·7046
2d experiment,	5·6987
By decomposition of chlorid of copper,	5·5523
2d experiment,	5·6978
By decomposition of perchlorid of iron:—	
1. Experiment with sublimed chlorid of iron,	5·4232
2. With perchlorid prepared in the moist way,	5·2867
By decomposition of chlorid of silver,	5·6056
2d experiment,	5·7234

As all bar iron contains more or less carbon, some decision should be made as to the limits up to which it should be called bar iron, and below which steel. If the limits are fixed by calling that bar iron steel which becomes so hard by cooling in water after having been hardened that it gives sparks with quartz, this effect occurs only when the iron has taken up 0·5 of carbon. Iron which is perfectly free from foreign ingredients may even combine with 0·65 per cent. of carbon before attaining the above degree of hardness. The purer the iron

and the less foreign substances (silicium, sulphur, phosphorus) it contains, the greater amount of carbon will it require in order to become much harder after the process of hardening than previous to it.

Iron which contains 0·5 to 0·65 per cent. of carbon is very soft steel; the hardness and tenacity of the steel increase with the amount of the carbon. From 1·4 to 1·5 per cent. appears to be the limit at which steel exhibits after hardening the greatest hardness with the greatest tenacity; with more carbon the hardness increases, but the malleability and tenacity of the steel are diminished; when it amounts to 1·75 per cent. the steel is very slightly malleable; with 1·9 it can scarcely be welded red-hot, and with 2 per cent. it breaks to pieces under the hammer. In this state the steel might already be called pig iron; but it may be beaten in the cold, and does not possess the property of separating a portion of its carbon in the form of graphite when allowed to cool very slowly after fusion. This occurs only when the carbon amounts to 2·25 or 2·3 per cent. If, therefore, a line of demarcation were to be drawn between steel and pig iron, which should be founded upon the combining proportions, 2·3 would characterize this limit.

The more carbon the pig iron takes up, from that minimum to the maximum of 5·93 per cent., the lighter does the color become, and the greater the hardness of the white variety, which is analogous to hardened steel. The gray variety, with an equal amount of carbon, which is analogous to unhardened steel, will be softer, that is, will separate the more graphite on solidification, the slower the cooling. The gray pig iron, which contains the same amount of carbon as the corresponding white kind, may consequently be sometimes a mixture of white pig iron with graphite, sometimes of soft steel or of hard bar iron and graphite, according as the solidification resulted more or less slowly, and the solidified mixture retained more or less carbon in the combined state. When the solidification is sudden, gray iron is scarcely formed, because the entire amount of carbon remains chemically combined with the iron, and is not separated as graphite.

In preparing cast steel, the process is purely empirical, the eye of the workmen being the weight and balance in determining the amount of carbon in the material to be employed. To manufacture cast steel with certain properties, those materials must be selected in which the amount of carbon is known, and which, by being fused together in accurately calculated proportions, produce a cast steel containing that amount of carbon which corresponds with the properties required of the cast steel to be prepared.

8. *Note on the Action of a Solution of Caustic Soda upon a Stoneware Jar;* by Mr. Trenham Reeks, (Chem. Gaz., April, 1847.)—The author's attention was drawn to this subject from the presence of a large quantity of alumina in the analyses of some bronzes and iron ores. On examining the reagents employed, it was found that it originated in the soda, which had been kept for some time in a stoneware jar, the alumina of which had been dissolved out by the soda, and a thick coating of silica left closely adhering to its surface.

9. *On the Detection of Cotton in Linen;* by G. C. KINDT, (Liebig's Annalen, Feb., 1846; Chem. Gaz., April, 1847.)—This subject has frequently engaged the attention of commercial and scientific men; many experiments have been made in order to detect cotton thread in linen; many processes have been recommended, but none have hitherto proved satisfactory. I was therefore much surprised when a stranger, a few weeks ago, showed me a sample of linen from the one-half of which all the cotton filaments had been eaten away. He had obtained it in Hamburg, and asked me whether I could give him a process for effecting this purpose. Now since, as far as I am aware, nothing has been published on this subject, and it is of very general interest, I consider it a duty to communicate the results of my experiments. I had already observed, in experimenting with explosive cotton, flax, &c., that these two substances behave somewhat differently towards concentrated acids; and although it has long been known that strong sulphuric acid converts all vegetable fibre into gum, and when the action is continued for a longer period, into sugar, I found that cotton was metamorphosed much more rapidly by the sulphuric acid than flax. It is therefore by means of *concentrated sulphuric acid* that cotton may be removed from linen when mixed with it; and this object may be effected by the following process:—

The sample to be examined must be freed as perfectly as possible from all dressing by repeated washing with hot rain or river-water, boiling for some length of time, and subsequent rinsing in the same water; and I may expressly observe, that its entire removal is requisite for the experiment to succeed. When it has been well dried, the sample is dipped for about half its length into common oil of vitriol, and kept there for about half a minute or to two minutes, according to the strength of the tissue. The immersed portion is seen to become transparent. It is now placed in water which dissolves out the gummy mass produced from the cotton; this solution may be expedited by a gentle rubbing with the fingers; but since it is not easy to remove the whole of the acid by repeated washing in fresh water, it is advisable to immerse the sample for a few instants in spirits of hartshorn, (purified potash or soda has the same effect,) and then to wash it again with water. After it has been freed from the greater portion of the moisture by gentle pressure between blotting-paper, it is dried. If it contained cotton, the cotton threads are found to be wanting in that portion which had been immersed in the acid; and by counting the threads of the two portions of the sample, its quantity may be very readily estimated.

If the sample has been allowed to remain too long in sulphuric acid, the linen threads likewise become brittle, or even eaten away; if it were not left a sufficient time in it, only a portion of the cotton threads have been removed; to make this sample useful, it must be washed, dried, and the immersion in the acid repeated. When the tissue under examination consists of pure linen, the portion immersed in the acid likewise becomes transparent, but more slowly and in a uniform manner, whereas in the mixed textures the cotton threads are already perfectly transparent, while the linen threads still continue white and opake. The sulphuric acid acts upon the flax thread of pure linen,

and the sample is even somewhat transparent after drying as far as the acid acted upon it, but all the threads in the sample can be seen in their whole course.

Cotton stuffs containing no linen dissolve quickly and entirely in the acid; or if left but one instant in it, become so brittle and gummy that no one will fail to recognize it as cotton when treated in the above manner.

10. *Nitrification and the Fertilization of Soils;* by F. KUHLMANN, (Comptes Rendus, Nov., 1846.)—The researches of this author published in 1838 are well known. By these he demonstrated that all the gaseous or vaporizable compounds of nitrogen, were converted into ammonia by the hydrogen and hydrogenous gases in contact with heated spongy platinum, and that on the other hand, all these compounds were converted into nitric acid or peroxyd of nitrogen, by oxygen or oxydating gases.

Upon this foundation the following view is based. Animal substances exercise a beneficial effect only when carbonate of ammonia is disengaged by their decomposition; in like manner, according to Kuhlmann, the nitrates are effectual as manures, only when the nitric acid has been converted into ammonia by the deoxydizing influence of putrid fermentation.

Various recent experiments are brought to prove that this opinion is correct, and that similar conversions to those observed in gases take place in liquids. Nitre thrown into a mixture of zinc or iron and sulphuric or better dilute hydrochloric acid, retards or stops the disengagement of hydrogen until the whole of the nitric acid is converted into ammonia. Nascent sulphuretted hydrogen produces the same effect, with deposition of sulphur. A current of sulphuretted hydrogen passed through a solution of chlorid of antimony and a nitrate, in like manner transforms the nitric acid into ammonia.

The author entertains the opinion that the ammonia of the atmosphere or of manures, is converted at the surface of the soil into nitrates, and that this process of nitrification prevents the waste of ammonia; these nitrates are in their turn deoxydized by fermentation and afford ammonia to the plant.

The peroxyd of manganese is proposed as an agent for the perpetual transference of the oxygen of the air to ammonia, producing its conversion into nitric acid; MnO_2 being deoxydized by the ammonia and the resulting MnO being converted by the air into Mn_3O_4, which in its turn is deoxydated.

M. Kuhlmann considers it possible, in case of a deficient supply of nitre in Europe, to convert ammonia into nitric acid economically—and on the contrary with the nitrates from India and Chili to form ammonia, by turning to account the hydrogen or sulphuretted hydrogen, which is lost in many operations and is even a source of injury to health. He also proposes a new process for determining nitric acid, based upon the conversion of nitrates into ammonia, under the influence of nascent hydrogen. G. C. S.

11. *Anhydrous Alcohol;* by M. CASORIA, (Phil. Mag., Nov., 1846, from Jour. de Chim. Med.)—Perfectly dry sulphate of copper is proposed as a means of rendering alcohol anhydrous, and as a test for the

presence of water in alcohol. The dry salt in combining with the water of the alcohol recovers its blue color, and when this color ceases to be produced, water is no longer present.

To obtain anhydrous alcohol, strong alcohol is to be saturated with chlorid of calcium, and the portion first distilled from it is to be treated with the dry sulphate until the blue color ceases to appear. These experiments should be performed in closed vessels, to prevent the interference of atmospheric moisture. G. C. S.

12. *On the Compounds of Phosphoric Acid with Aniline;* by Ed. C. Nicholson, (Phil. Mag., Jan., 1847.)—The facility with which the salts of aniline crystallize, led to the attempt to investigate its several phosphates, which might be supposed analogous to the phosphates of ammonia. Two tribasic phosphates were obtained, one being $2(HO, C_{12}H_7N)HO, PO_5$, the other $(HO, C_{12}H_7N,)$ $2HO, PO_5$, corresponding to the ammonia salts, and like them anhydrous. The attempt to form the salt with three equivalents of base or one containing soda (analogous to microcosmic salt) was unsuccessful. Two pyrophosphates were formed at the same time, acid and neutral; the latter could not be isolated; the former $(HO, C_{12}H_7N,)$ $HO. PO_5$ corresponds to acid phyrophosphate of soda, but has no analogue in the ammonia series.

The metaphosphate was formed similar to the soda salt; the ammonia salt exists only in solution.

The conclusion is a natural one, that organic bases form series of salts with polybasic acids resembling those of the metallic oxyds. G. C. S.

13. *On the relations of Glycocoll and Alcargene;* by Mr. Thomas S. Hunt.—We have received an interesting paper from Mr. Hunt on the relations of these two bodies, which we defer to our next number. He points out the fact that the formulas of the two bodies are the same, excepting the substitution of As for N, and instances some of the homologous compounds as follows:—

Glycocoll,	$C_4 H_5 NO_4$	Alcargene,	$C_4 H_5 AsO_4$
Argentic "	$C_4 (H_4 Ag) NO_4$	Argentic "	$C_4 (H_4 Ag) AsO_4$
Hydrochloric "	$C_4 H_5 NO_4, HCl$	Hydrochloric "	$C_4 H_5 AsO_4, HCl$

II. Mineralogy and Geology.

1. *Hauerite, a New Mineral Species;* by W. Haidinger, (Poggendorff's Annalen, Vol. lxx, p. 148.)—Hauerite belongs to Mohs's order of blende, and resembles very much several true brown zinc-blendes. Its crystals belong to the tessular system: they are partly perfect octahedrons, partly combinations of this form with faces of the hexahedron and other modifying planes.

One of the two crystals submitted to my examination by Mr. Berghofer, is a perfect and distinct octahedron, whose axis measures three quarters of an inch. The mineral cleaves with extreme facility parallel to the faces of the cube. Its lustre is between metallic adamantine and imperfectly metallic; the color ranges between dark reddish-brown and brownish-black, and in the thinnest films obtained by cleav-

age, it shows a low degree of brownish-red translucency; streak brownish-red; hardness = 4·0, or that of fluor; specific gravity, according to von Hauer, 3·463.

In a glass tube before the blowpipe, an abundance of sulphur is given off, leaving a green residue soluble in acids with a disengagement of sulphuretted hydrogen. This residue when treated alone becomes superficially brown again, before the blowpipe. A fragment treated with salt of phosphorus does not (as is also true of manganese-blende from Nagyág) become of a violet color in the outer flame, until the whole of the sulphuret of manganese is decomposed. Upon platina foil with soda, it gives the reaction of manganese. In composition, it would therefore seem to be a higher grade of sulphuret of manganese; and guided by its isomorphism with iron pyrites, which is expressed by the formula $Fe\,S^2$, we may infer that the formula of Hauerite is $Mn\,S^2$.

According to the analysis of W. Adolphus Patera, the composition of the substance in question is as follows: sulphur 53·64, manganese 42·97, iron 1·30, silica 1·20 = 99·11, calculating the iron as sulphuret of iron, and deducting it, this would give, in one hundred parts,

	Analysis.	Calculation.
Sulphur,	54·801	53·7
Manganese,	45·198	46·3

It is remarkable that the form of the only sulphuret of manganese, with which we were hitherto acquainted, (manganese-blende, alabandine,) and whose composition is MnS, should likewise belong to the tessular system, and also show distinct cleavage parallel to the faces of the cube. Alabandine, however, is more semi-metallic in lustre, has a green streak, and gives off no sulphur in a glass tube before the blowpipe.

The writer first took the crystals from their color, form, streak, and manner of grouping, for weathered iron pyrites, when his attention was drawn by Mr. von Hauer to their perfect hexahedral cleavage; further investigation then established the distinctness of this beautiful species beyond a doubt.

Hauerite occurs at the sulphur-pits at Kalinka near Végles, in the neighborhood of Altsohl in Hungary. The crystals are met with in clay and in gypsum, occasionally associated with sulphur of a fine yellow tint, which is nearly transparent. They occur either insulated or grouped together like certain varieties of globular iron pyrites.

The name proposed was given this species as an acknowledgment of the high merits of his excellency the Privy Counsellor and Vice President, von Hauer, and because of the part which his son, Mr. F. von Hauer, took in the determination of the species. The substance was first noticed by Mr. C. v. Adler, at that time employed at Kalinka, and from this gentleman several persons received specimens. Hauerite will perhaps always remain a mineralogical rarity. The writer however looks forward with pleasure to the receipt of further specimens direct from the mining authorities of Lower Hungary.

2. *Coal and Iron in India*, (Mining Journal, April 10, 1847.)—As it has now been determined by the East India Company, and supported by government, that the railway system shall be extended to India, and a guarantee given for a dividend on the capital invested, any in-

formation respecting the localities from which supplies of fuel can be drawn, must prove interesting, and not less so the capabilities for the manufacture of iron. Hitherto the iron mines of India—though yielding iron in no respect inferior to the famous mines of Dannemora—have been scarcely opened, from the deficiency of the means of transport; and the coal-fields, though of great richness and extent, have lain neglected, principally from the same cause. The coal-fields of India are largely distributed over its surface; coal has been traced from Burdwan to the westward, across the valley of Palamow, through the district of Sohagpore to Jubulpore, the neighborhood of Sak, and the Towa River, in Nerbudda—four hundred and twenty miles from Burdwan. In the same parallel of latitude it is found in the province of Cutch, and is extended across the centre of India, to the northeast extremity of Assam, forming a zone, which stretches from 69° to 93° east longitude, and from 20° to 25° north latitude. There are also two situations where coal has been found distinct from this extensive and well-defined belt—Hurdwar and Attock—the first near the source of the Ganges; the latter, near that of the Indus. The Nerbudda river extends seven hundred miles along the very centre of the above zone; and coal in three situations has already been found on its banks. The Burdwan coal-field is of immense importance; the collieries at present opened are situated one hundred and forty miles from Calcutta, and the district is traversed by two rivers—the Damooda and the Adjii; the face of the country is undulating, presenting a difference of level between the heights and valleys of about sixty feet. The surface is composed of a yellow clay, supporting a good soil—both slightly calcareous; this clay rests on a grey sandstone, which effervesces with acids, seven feet in thickness; and where exposed to the air, in many places an efflorescence of soda is found upon it. Beneath this rock, an inferior coal is found, accompanied by shale, containing impressions of plants, bending over the low hills, and descending deep beneath the valleys; beneath these, good coals are found: and this portion of the deposit has been traced in a southwest direction eleven or twelve miles, and in a northwest line for seven miles—thus forming a curve. At a depth of about fifty feet, two beds of excellent coal occur—one, eight feet, and the other nine feet in thickness; below these, thirteen beds of sandstone and shales occur; and the greatest depth reached is eighty-eight feet, where the excavation is terminated by a hard grey sandstone. The whole district abounds in rich and valuable iron ores of various kinds; and it has been proved, by the erection of temporary furnaces at Sheargur, that immense quantities of iron can be made at little expense. The average of the ores produce fifty per cent. of iron. A prospectus, drawn up in 1828, pointing out the benefits likely to arise from establishing iron-works in India, led to the formation of the Porto Novo Works, near Madras, now in succesful operation; and, as the subject is one of immense importance to the construction of railroads in India, we shall, in a future number, give the substance of a report by Capt. Campbell, which will, doubtless, throw much light on the present position of the coal and iron districts.

3. *On Slaty Cleavage;* by DANIEL SHARPE, (Quart. Jour. Geol. Soc., No. 9, p. 74.)—Mr. Sharpe commences his very valuable article

on slaty cleavage by describing the various distorted forms of certain species of shells in fissile rocks, showing that these forms depend on the positions of the shells with relation to the direction of cleavage. He observes that the same shells in rocks that are not fissile are not thus distorted; and on a single slab or layer the various specimens are all distorted in the same direction. This observation led him to throw together many species which he had before considered distinct.

He illustrates the subject by figures of distorted forms of the *Spirifer giganteus* and *Sp. disjunctus* from Tintagel and South Petherwin, copies of which, reduced one-half, are here given. (We have collected together the several separate cuts of Mr. Sharpe for more convenient comparison.)

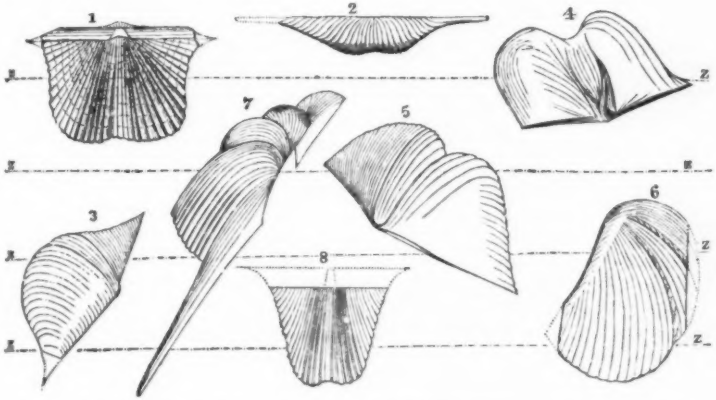


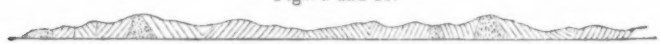
Figure 1 to 4, *Spirifer disjunctus*; 5 to 8, *Spirifer giganteus*. All reduced one-half, except fig. 8, which is reduced two-thirds.

Fig. 1 represents the *S. disjunctus* of its proper form, and the following are distorted shells of this species and *giganteus*. The lines zz mark the direction of the lines of cleavage. These shells, he remarks, are usually flattened or narrowed in a direction *perpendicular* to the cleavage, and drawn out, or pressed out, in the direction of the dip of the cleavage planes. Figure 2 represents a specimen which so lay in the rock as to intersect the slate layers at an angle of 60°; it is shortened one-half by the distorting force. Figure 3 is an example of a cast lying at an angle with the slaty structure of 10° or 15°; the force causing distortion has pressed together the shell on one side of the middle line and lengthened it out on the other; and at the same time the shell is compressed at right angles with the cleavage. Figure 4 represents another cast in a different position; the large part of the shell is pressed under the other part and concealed, and at the same time the remainder is so expanded that the impressions of the hinge portion are nearly double their usual length, this expansion taking place "as usual in the direction of the dip of the cleavage." Figure 5 (a cast of *Spirifer giganteus*) represents a case nearly like figure 3, in which the plane of bedding of the shell made an angle of less than 5° with the cleavage; the

lower half is very much expanded in the plane of cleavage, and has lost thereby its radiations. In figure 6 there is the same angle between the plane of bedding and dip of cleavage, but a different position of the shell, in consequence of which one-half was extremely shortened, while the other was as remarkably widened. In figure 7 a still more singularly lengthened cast of *S. giganteus* is shown; it was from a bed where the cleavage intersected it at an angle of 1° only. The elongated half of the cast of the hinge is here three times the length of the other half, and the hinge area is singularly widened, while a great part of the cast of the body of the shell is lost. Figure 8 represents a specimen (imperfect in the hinge portion) expanded in the direction of its length; although not seen in place, Mr. Sharpe observes that there can be little doubt that the distortion took place in a direction parallel to the dip of the cleavage planes. He concludes from the various facts, that the existing forms may be accounted for by supposing that *the rocks* in which they are imbedded *have undergone compression in a direction perpendicular to the planes of cleavage, and a corresponding expansion in the direction of the dip of the cleavage.*

Mr. Sharpe next considers the uniformity of the strike of the dip over large areas, and its parallelism to the anticlinal axes or the ranges of mountains, a view which we believe was first brought out by Necker. He mentions the long lines of uniform strike of cleavage in North Wales, Devonshire, and Cornwall, and the opposite dip on the different sides of the lines of vertical dip; and he supports the view presented by Mr. Darwin in his work on South America, that this variation in the dip may arise from the planes of cleavage bending in the direction of great curves more or less abrupt. He points out two parallel lines of vertical cleavage in North Wales thirty-five miles apart, having a nearly northeast strike, either side of which the dip gradually diminishes. Other similar examples also are pointed out. A relation between the inclination of the cleavage planes and the elevation of the strata is apparent in the beds; the dip of the cleavage is greater the greater that of the bedding, though the two differ much. In North Wales the cleavage planes usually dip 20° or 30° more than the bedding; while in the middle of Devonshire and Cornwall they are less inclined than the bedding. In the following section (figure 9) in Carnarvonshire,

Figs. 9 and 10.



North Wales, there are several anticlinal and synclinal axes of the stratification, yet, as shown in figure 10, only one axis of cleavage. The several anticlinal and synclinal axes, excepting the central one, have not influenced the cleavage, which follows uniformly its own direction through beds dipping in opposite directions. "Still there is so much relation between the direction of the cleavage planes and the position of the beds, that we might infer from this section alone, that the cause which produced the cleavage of the rocks had helped to determine the elevation of the beds."

In Devonshire he establishes two lines of vertical cleavage, sixty miles apart, one at Stoke Fleming the other at Bickington; and they bound a broad area over which the cleavage planes undulate in low flat waves, the axes of which bear between E. and E.N.E. The annexed cut represents the relation of the planes of bedding and cleavage in these undulations near Launcestown and on the coast near Tintagel. The continuous lines represent the bedding and the dotted lines the cleavage. After stating other similar facts from different districts in England, Mr. Sharpe remarks as follows, with regard to the relation of the cleavage planes to the bedding in Devonshire:—

Fig. 11.

"Throughout the central area where the cleavage is nearly horizontal, the beds undulate in a succession of waves already described without offering any marked features. These undulations are sharper towards Bideford, where we may expect to find the cleavage highly inclined. At the Bickington limestone quarry, where the vertical line of cleavage passes, the beds are most violently contorted. Beyond this line is low ground at Barnstaple, in the band between the two lines of vertical cleavage. From Pilton to Ilfracombe, with cleavage highly inclined, the strata are elevated in high hills, and at Linton, where the inclination of the cleavage is only 35°, the beds seldom dip more than 5°. So again on the S. coast of Devonshire, disturbed and elevated strata occur in company with highly inclined cleavage. These observations are less complete than those relating to Carnarvonshire, but the theoretical conclusions to be derived from them are the same.

"The regularity of the direction of the cleavage is not at all broken in the neighborhood of the granite of these counties, from which it is to be inferred that the granitic eruptions had taken place and become solid before the cleavage was produced: indeed some remarks of Sir H. T. De la Beche lead me to suppose that the cleavage is continued through the granite."

Mr. Sharpe having deduced from the distorted shells that "the slaty rocks had undergone compression in a direction perpendicular to the planes of cleavage," and "that this compression was compensated by an expansion in the direction of the dip of the cleavage," enters upon an explanation of the non-conformity of the bedding to the cleavage planes. Assuming that the elevation was produced by an elevating force beneath the area, he argues that there will result from such elevating action, besides a grand central arch or anticlinal axis, other subordinate fractures and dislocations either side; and that thus the various anticlinal axes in figure 9 were produced, while only the main or central one influenced the direction of the cleavage planes. With regard to the manner in which the cleavage structure has been occasioned, or the cause of this peculiar feature, Mr. Sharpe simply enumerates some of the views which have been presented, expressing at the same time the hope that the observations he has made may hasten its discovery: an end which must surely be promoted by observations of so great interest followed out with the care and discrimination exhibited in the important memoir, of which a brief abstract has been here presented.

4. *Geological Society of London*, April 14th, 1847.—A paper was read, entitled, "On the Structure and probable Age of the Coal Field of the James river, near Richmond, Virginia;" by Charles Lyell, F.R.S., V.P.G.S.

This coal field, which is about twenty miles long from north to south and from four to twelve in breadth from east to west, is situated twelve miles west of Richmond in Virginia, in the midst of a granitic region. The rocks consisting of quartzose grits, sandstones, and shales, precisely agree in character with the ordinary coal measures of Europe. Several rich seams of bituminous coal (the principal one being occasionally from thirty to forty feet thick) occur in the lower division of the strata, which are arranged in a trough and are much disturbed and dislocated on the margin of the basin, where they have a steep dip, while they are horizontal towards the centre.

The fossil plants which have been determined by Mr. Charles Bunbury, differ specifically, and most of them generically, from those found fossil in the older or palæozoic coal formation of Europe and North America, and resemble, as Prof. W. B. Rogers first truly remarked in 1840, the plants of the oolite of Whitby in Yorkshire, some few however being allied to fossils of the European trias.

From the upright position of the Calamites and Equisetæ Mr. Lyell infers that the vegetables which produced the coal grew on the spots where the coal is now found, and that the strata were formed during the continued subsidence and repeated submergence of this part of Virginia. The shells consist of countless individuals of a species of Possidonomya, much resembling *P. minuta* of the English trias. The fossil fish are homocercal and differ from those previously found in the new red sandstone (trias?) of the United States. Two of them belong to a new genus and one to a Tetragonolepis, and they are considered by Prof. Agassiz and Sir P. Egerton to indicate the liassic period.

The analysis of the coal made by Dr. Percy and Mr. Henry, shows that it contains the same elements, carbon, oxygen, hydrogen and nitrogen, in the same proportions as the older bituminous coal of Europe and North America. Alternating layers of crystalline coal, and others like charcoal, are observed in many places, and in the charcoal, Dr. Hooker has detected vegetable structure not of Ferns or Zamites or any conifer, but perhaps of Calamites. The coal yields abundance of gas used for lighting the streets of New York and Philadelphia, and some fatal explosions have taken place in the mines, some of which are nine hundred feet deep.

Volcanic rocks (dikes and beds of intrusive greenstone) intersect the coal measures in several places, hardening the shale and altering the associated coal, the latter being in some places turned into a coke used largely for furnaces.

The author concludes by expressing his opinion that the evidence of the fossils, although some of them belong to forms usually found in the trias, preponderates upon the whole in favor of regarding the coal field of the James river as being of the age of the inferior oolite and lias.*

A paper was next read, entitled, "Descriptions of Fossil Plants from the Coal Field near Richmond, Virginia;" by CHARLES J. F. BUNBURY, F.L.S., F.G.S.

* For the memoir of Prof. Wm. B. Rogers, in which this conclusion was sustained by the same arguments in 1842, see Report Assoc. Amer. Geol. and Nat., 1840–1842, p. 298.

The author describes fifteen different forms of vegetable remains, of which, however, only nine or ten are sufficiently well preserved to be determined with any precision. Six are Ferns, of which three belong to *Pecopteris*, one to *Tæniopteris*, one to *Neuropteris*, and the sixth appears not to be referable to any genus hitherto described. The *Neuropteris*, and one of the species of *Pecopteris*, are new. One of the ferns is believed to be identical with *Pecopteris whitbiensis*, a species characteristic of the oolites of the Yorkshire coast. There is one species of *Equisetum*,—*E. columnare*—likewise characteristic of the Yorkshire oolites; one, or perhaps two of *Calamites;* two (which may possibly be mere varieties) of *Zamites;* the remainder are obscure impressions of an equivocal nature, but of which one has a certain degree of resemblance to a *Stigmaria*, and another to a *Lepidodendron*.

Five of these fossil plants had previously been determined and described by Prof. W. B. Rogers, namely, *Tæniopteris magnifolia*, *Pecopteris whitbiensis*, *Equisetum columnare*, *Calamites arenaceus*, and *Zamites obtusifolius*. Prof. Rogers described also a few other species, which do not occur in the collection made by Mr. Lyell.

From a comparison of these vegetable remains with those found in European strata, of which the geological position is well known, it may be concluded with tolerable certainty, that the Richmond coal-field is of later date than the great carboniferous system, and that it must be referred either to the lower part of the Jurassic, or the upper part of the Triassic series,—more probably to the former.

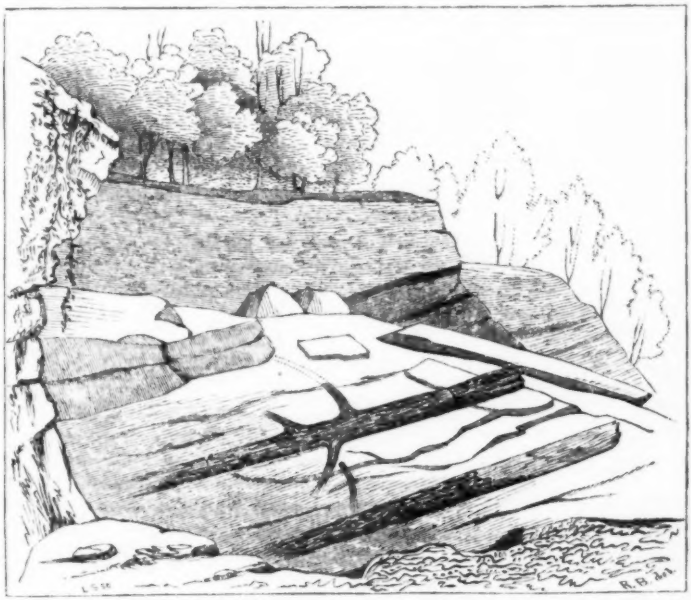
5. *Remarks on a Boulder Mass of Native Copper from the southern shore of Lake Superior;* by Forrest Shepherd, (communicated by request, to Prof. Silliman, for this Journal.)—The mass of native copper in my possession, was discovered on the southern shore of Lake Superior in July, 1845, by Tousant Piquette (an Indian of the Ojibwa tribe) in or near latitude 47° 5′ north, and longitude 88° 5′ west. It is composed almost entirely of pure native copper with spots of pure metallic silver upon its surface, together with a few water-worn pebbles of syenite, sandstone, &c., strongly imbedded and fastened in its cavities and sinuosities. Its length is about three feet and a half, its breadth two feet and a half, thickness from seven to eight inches, and its weight sixteen hundred and twenty-five pounds. As a specimen, its form and proportions could not well be better. One end is broader by a few inches than its opposite. One side discovers a slight natural rotundity and also a deep furrow cut obliquely into the solid metal, while the other side, nearly flat, appears much worn and polished in some places, whilst in other places it exhibits numerous grooves, scratches and broad longitudinal furrows, showing evidently that the mass has at some period been subject to great external violence. When found it was situated immediately upon the shore about three miles northeast of Elm river, not more than two or three feet above the water, and only about six feet from the broad side of the lake. It was standing on its smaller end, nearly in a perpendicular position, leaning slightly against a much larger boulder of sienite. The lower end was buried in the gravel of the shore about ten inches, and immediately underneath it were found pebbles and small boulders of porphyritic greenstone, syenite, sandstone, &c., and also an undecayed log of white cedar (arbor vitæ) on which it rested. Around it, both in the lake, and upon

the neighboring shore, and occupying a space of several acres, were seen in promiscuous assemblage, a multitude of boulders both large and small, composed chiefly of granite, syenite, greenstone, conglomerate, and red sandstone, apparently the companions of this extraordinary specimen. There is no stream of any magnitude or importance nearer than Elm river (three miles), which although called a river, is not more than twelve or fifteen feet in breadth. All along this coast and for many miles southward is a dense forest of large trees, such as white cedar, spruce, hemlock, pine, poplar, birch and maple; the growth of which, must have occupied four or five centuries.

The stratum of rock underneath this assemblage of boulders is red sandstone nearly horizontal, dipping northward into the lake at an angle of two or three degrees. About eight or ten miles southward is a ridge of stratified greenstone, generally called trap by explorers in this region. This ridge runs northeast and southwest nearly, and attains a height of five or six hundred feet. In this greenstone are numerous veins containing native copper with occasional spots of silver. These veins or lodes of copper, cut the above ridge at right angles and extend into a formation of conglomerate which reclines immediately upon the greenstone. Native copper is found also in the conglomerate. The red sandstone above mentioned reposes upon the conglomerate, so that there is a gradual descent from the summit of the greenstone ridge to the shore of the lake (a distance of eight or ten miles) where the copper boulder was discovered. From the adhesion of pebbles to the depressed and cavernous portions of this copper boulder, there is strong probability that it was derived from a vein in the conglomerate. But it could not have well been removed from the neighboring ridge, since the existence of the present forest; and it has evidently been deposited in the place where it was discovered, since the growth of the medium sized arbor vitæ on which it rested. The shore of the lake at this place is of moderate elevation varying from six to ten or twelve feet. The island of Isle Royal with its sandstone conglomerate, porphyry, and greenstone, is situated about fifty miles due north, and granite and syenite, similar to the boulders, accompanying the copper rock, exist in place on the northern shore of the lake, a distance of one hundred miles or upwards. No rocks of this description are known to exist nearer *in situ*.

6. *On Fossil Trees found at Bristol, Conn., in the New Red Sandstone.*—Two fossil trees have recently been discovered by the quarrymen who were excavating building stones in a sandstone quarry on the banks of the Pequabuck river in the town of Bristol, Connecticut. This town is on the western border of the greater secondary basin of Connecticut, and the locality where these fossil trees were found is not far from the junction of this deposit with the western primary ranges. The sandstone beds which crop out upon the banks of the Pequabuck, are fine grained, argillaceous and well adapted for many architectural purposes. No organic remains have before been observed in them, with the exception of a few ill characterized and obscure impressions of reed-like vegetation, upon the surface of a fissile stratum of argillaceous sandstone which is met with at a point about four feet above the bed containing the trees.

The writer's attention was called to these fossils by a letter from Mr. N. S. Manross of Bristol, (a member of the academical department of Yale College,) whose father owns the quarry where they were found. This gentleman had the consideration to preserve these interesting relics from destruction until they had been visited by the writer in company with R. Bakewell, Esq., to whom we are indebted for the accompanying sketch of the quarry with the two trees as they appeared, at the time of our visit.



It will be observed that the trunks are nearly parallel to each other in the plane of stratification of the beds, and nearly at right angles to the strike of the strata. Their buts point toward the river, while their heads are buried beneath the unopened sandstone. Several branches were to be traced from the principal trunk, one of which reached (in the dotted line) to the distance of eight or ten feet from the body and nearly at right angles with it. The bed in which these trunks were found is quite unlike the fine grained red deposits above and below them, being a rather coarse grained grey quartzose grit, sprinkled with mica and carbonaceous particles. It is very tender and friable when first exposed, and the trees which were imbedded in it were not properly petrified, but existed in the condition of soft lignite, in which the vegetable structure could be detected only on close observations. A rough exterior having the general appearance of the outer bark of the common yellow pine, was all the general character that could be observed. They were much flattened by the pressure of superincumbent rocks, not being over four inches thick in the thickest parts and thinning out to the edges. The

greatest breadth of the trunk of the larger tree was about one foot, and it diminished from this very gradually for about fifteen feet, which is the extreme length to which they have been uncovered. The stem of the larger tree was divided transversely at nearly regular intervals of about fourteen inches by a cleft or notch, which corresponded to a similar ridge or prominence in the sandstone, both above and below. The two trees are not in the same plane, as may be seen in the sketch which correctly represents the smaller tree in the foreground as about two feet below the larger and three feet distant from it. The cast or impression of the larger tree gives its characters more distinctly than the stem itself: and this impression also measures in diameter considerably more than the trunk which it represents, showing that the latter has shrunk from its original dimensions.

The thickness of deposits over these trees is not more than six feet of sandstone and the same amount of diluvium; but this gives us no idea of the thickness which has undoubtedly been removed by denudation. A microscopical examination of specimens of the trunks of these two trees has been kindly undertaken by my friend, Prof. J. W. Bailey of West Point, who confirms the supposition that they were coniferous.

No cones or leaves could be detected in this locality, nor had any such, or in fact any other fossils, been obtained by the quarrymen, although there is a tradition that many years since, trunks of trees were found in a quarry near the present one. Mr. Manross has made particular search here for footmarks similar to those found in other parts of this deposit, but without success. By the zeal and good management of this young gentleman, about four feet in length of the larger tree was successfully removed with its corresponding capping of sandstone, and now forms one of the ornaments of the geological collection of Yale College. The writer supposes that this is the first instance in which the trunks of hard-wooded trees have been observed *in situ* in the Connecticut sandstone. Fragments of agatized wood have been found in Massachusetts by Prof. Hitchcock, and in the smaller secondary basin of Southbury, Ct., and large stems of reed-like plants are found in the beds which furnish the fish at Middlefield in the same state.

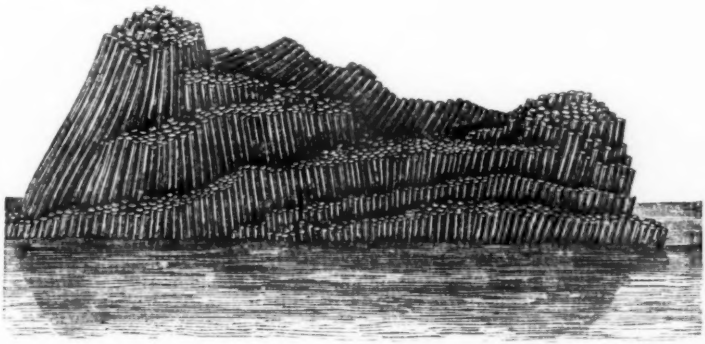
B. Silliman, Jr.

Yale College Laboratory, June 1, 1847.

7. *Observation on the Basaltic Formation on the northern shore of Lake Superior;* by T. R. Dutton, (communicated for this Journal.)—The display of igneous rocks on the north shore of Lake Superior is one of great interest to the geologist, both on account of the variety of the different formations, their relations to the adjacent slates, and the fact that some of them are the repositories of copper and silver.—Among these instructive rocks may be found, granite of a more recent date than the Devonian strata, sienite, porphyry, greenstone and trap, both compact, amygdaloidal and basaltic. It is of the last-mentioned formation that we now speak.

The numerous islands which occupy the most northern part of the lake are composed of trap and porphyry with underlying sandstone, and must be considered as one of the most important parts of the metalliferous region of the northern shore. On the southern shore of Simpson's Island and the southeastern of St. Ignace, the two largest of

these islands, the trap presents the columnar form which is represented in the accompanying cut (drawn by Capt. Stannard) of a section forty feet long and twenty feet high.



The cliffs of this formation which extend for a distance of about three miles, are rarely more than sixty feet in height, and are composed of columns which are usually pentagonal or hexagonal in form, and which, though they are for the most part nearly perpendicular, are often inclined at different angles and sometimes bent. They are twenty or thirty feet long, and from six to eighteen inches in diameter; but they seldom present that distinctness in their columnar structure, and the transverse joints, which characterize the basalt of the Giant's Causeway.

III. Botany and Zoology.

1. *Notes on a Tour to Madeira, Teneriffe and Cape Verds, from the Journal of the Voyage of* Dr. J. R. T. Vogel *to the Niger*, (Lond. Jour. Bot., No. lxiii, March 1, 1847, p. 125.)—The Island of Madeira contains six hundred and seventy-two species of flowering plants and Ferns, of which eighty-five are absolutely peculiar, and four hundred and eighty common to Europe; two hundred and eighty are common to Madeira and the Azores (whose Flora is estimated at four hundred and twenty-five species); three hundred and twelve (or probably more) to Madeira and the Canaries; and one hundred and seventy to the neighborhood of Gibraltar (where four hundred and fifty-six have been collected).

It is remarkable that out of four hundred European (and these Mediterranean) species, indigenous to Madeira, not more than one hundred and seventy occur in Gibraltar; for it were natural to suppose that the majority of four hundred and eighty species which are very widely dispersed throughout the S. of Europe, should have migrated by way of Gibraltar, if transported across the ocean to Madeira. It is further worthy of observation, that the Azores, though very far to the westward, and the Canaries to the south, both contain many more of the Mediterranean plants seen in Madeira, than does Gibraltar.

A considerable number of the Madeira plants belong to genera not found in the adjacent continent, but in the Canaries, Azores, or Cape de Verd Islands; thus indicating a botanical affinity between these groups, and confined to them.

The evidence of this relationship is very decided, from the peculiarity of the genera or species giving rise to it. Though comparatively few in number, their characters are so prominent and so widely different from the Mediterranean plants which accompany them, that the latter, though numerically much the greatest, seem superadded, and, as it were, intruders on the former.

The Canaries and Madeira, from their central position and various other causes, are the centre of this botanical region, called by Mr. Webb the "Macronesian," and exhibit more peculiarity than the Cape de Verds, (as far as they are at present known,) or the Azores. There can be little doubt that Madeira was even more peculiar in its vegetation than now, previous to the destruction by fire of the luxuriant forests, which, according to historic evidence, clothed almost all the lower parts of the island. Not only would such a catastrophe destroy species, but their place would be afterwards occupied by strong-growing imported weeds, which would prevent the reappearance of the native plants by monopolizing the soil.

With very few exceptions, the Mediterranean are the only plants found in Madeira and the Canaries besides what are confined to those islands; in the Azores, on the other hand, some Northern European species are associated with them. In the Cape de Verds, far to the south, W. African and W. Indian plants replace those of the Mediterranean.

The Island of Madeira participates in the flora of the W. Indies to a much greater degree than does any part of the adjacent continent:—that this is in a great measure due to the dampness of its insular climate, is clear, from the plants in question being almost entirely Ferns, viz.:—Acrostichum squamosum, *Sw.* Aspidium molle, *Sw.* Asplenium monanthemum, *Sw.* Asplenium furcatum, *Sw.* Trichomanes radicans, *Sw.*, species found no where on the continent of Europe, nor in N. Africa. The presence of a plant belonging to the otherwise exclusively American genus, *Clethra*, is striking, because indicating a further relationship with the Flora of the New World, but of a very different character from the above.

The *Helichrysa* of Madeira are allied in rather a remarkable degree to the S. African species of that genus; a fact which reminds us that the *Myrsine Africana*, a Cape of Good Hope plant, is a native of the Azores, but of no intervening latitude on the West coast of Africa or the Atlantic Islands, or indeed any where else but Abyssinia. Though not a subject falling immediately within the province of the pure botanist, it may not be amiss here to state, that the four Island-groups in question have been conceived by my friend, Professor Forbes, to be the remains of one continuous and extended tract of land, which formed the western prolongation of the European and African shores. He points to the identity of species between these islands and Europe, as affording botanical evidence of this ingenious theory, which, how-

ever, he chiefly rests on geological grounds. Regarded in this light, the question will resolve itself, in the opinion of most botanists, into one, concerning the power of migration, and the probability of migration having taken place, to a very great extent, over the Atlantic Ocean, and against the prevailing direction of the winds. It may be contended that such a migration would have peopled these islands solely, or mainly, with certain of the more transportable classes of plants; and that the result must be, that the number of species belonging to each natural order would be great in proportion to the facility with which they bear transportation; while only those orders could be numerous, which possess that faculty in an eminent degree. But such are not the characteristics of the Mediterranean plants found in Madeira.

On the other hand, the existence of such a continent, during the period when these islands bore the plants which they now produce, would argue the former presence of a very large Flora belonging to the type which now distinguishes the islands in question from the Mediterranean, and of whose previous existence the remaining species, peculiar to them, are the indication. Against this theory it might be urged, that more specific identity between the plants of the several insular groups than now is seen, would then be the natural consequence; for the affinity of vegetation between the different islands consists, not in identical species, but in representatives. The same agent, in short, which effected the peopling of the several groups with the plants of continental Europe, would also have distributed more equally the non-European species over the same area.

It is, however, to the lofty peaks of Atlas that we must look, if any where, for the continental representatives of those peculiar plants which mark the North Atlantic Insular Floras. Thus, we expect to find the productions of the Galapagos Archipelago on the higher levels of the Cordillera; and the mountains of St. Thomas, Fernando Po and the Cameroons, on the west coast of tropical Africa, may yet exhibit to us the botanical features of St. Helena. Outlying and high islands commonly partake in the peculiar vegetation of a climate cooler than belongs to the low lands of the adjacent continent; though, in the case of Juan Fernandez, they sometimes exhibit genera equally isolated in botanical affinities as their habitats are in geographical position.

Teneriffe.—The next point visited by the Niger Expedition, after leaving Madeira, was the Island of Teneriffe, where the vessel in which Vogel had embarked remained but a few hours. The same island, and the same port, Santa Cruz, had been touched at by the Antarctic Expedition during the previous winter. Teneriffe is always held to be classic ground by the naturalist, as the opening scene of the labors of Humboldt, who there first appreciated in their full extent the laws governing the geographical distribution of plants. His lifelike pictures of the natural phenomena, observed during an ascent of the famous peak, have given an impulse to many succeeding scientific travellers, which has turned their thoughts and steps from closet studies and the pursuit of natural history at home, to seek far distant scenes, in the West, the East and the South.

The Peak itself is seldom descried: one hurried glimpse of its very apex, from upwards of sixty miles distance, was all we obtained: it

then appeared like a little short and broad cone high in the clouds, or rather, as an opaque triangular spot on the firmament. It is difficult to imagine this, the culminant point, to be that mighty mass, at whose base the toil-worn traveller pauses; when, having surmounted four-fifths of the mountain, his heart quails at beholding a "Pelion upon Ossa piled" so sternly, so stony and so steep.

Much and deeply did the officers of Captain Ross and Trotter's Expeditions deplore the necessity of hurrying from this spot, so interesting to the sailor, it being the point to which every circumnavigator first steers, and from whence, with chronometers carefully corrected at its well-determined position, he takes his departure. For years, too, this was the prime meridian; distance in longitude at sea being reckoned from Teneriffe as zero, by all the seafaring nations of Europe at one period: and by some it is so still. From the days of the earliest circumnavigators, to the present, "we sighted the Peak of Teneriffe" marks that page in the narrative, at which all that is interesting in the voyage commences.

In the history of geology, the Canary Islands hold a conspicuous position: von Buch developed his theory of craters of elevation from what he there observed: his name too recalls, and most appropriately, that of his fellow-laborer in the same shores, Christian Smith, the amiable and gifted Swede, who first after Humboldt, explored their botany. Christian Smith returned to Europe to embark in the ill-fated Congo Expedition: when he again saw the Peak of Teneriffe, he welcomed it as a familiar object, and bade it adieu, rejoicing that a still more novel field of inquiry was opened to him, beyond this scene of his early exertions. A few short months terminated his life and hopes: like Vogel, he fell a victim to the dreaded fever of the pestilential coast of Africa: like him, too, he was a martyr in the cause of botanical science.

Possessed of so many and such touching associations, no naturalist-voyager can see the Fortunate Isles rising, one by one, on the horizon of the mighty Atlantic, without some feeling of melancholy, while reflecting on the fate of these his two predecessors, both most accomplished naturalists of their age and day; and whose prospects and hopes were in every respect as bright, perhaps brighter, than his own.

The excellent and beautiful work of Mr. Webb, on the Natural History of the Canaries, leaves little to be said, especially of their botany; and renders even an enumeration of the few species gathered by Vogel and the Botanist of the Antarctic Expedition unnecessary; for they were all collected within a few miles of Santa Cruz, during a very hurried walk, and scarcely include a dozen kinds. This locality is one of the most barren of the whole group, especially in the immediate neighborhood of the sea. The broad frontage of cliff and mountain, reaching upwards for several thousand feet above the town, and fore-shortened to the view from seaward, presents a progressive increase of verdure from the water's edge to the mountains. At this season, when the vines are out of leaf, nothing green meets the eye; the trees, either isolated or in very small clumps, only dot the alternate ridges and steep gullies with which the slopes are everywhere cut like the edge of a saw, producing that spotty effect in the landscape so admirably transferred to the phytographical illustrations of the work allu-

ded to, and which is eminently characteristic both of the Canaries and Madeira.

The *Kleinia*, *Euphorbia* and *Plocama* are three plants which the voyager recognizes long before reaching the shore; and they are so singular, whether as regards habit, habitat, or botanical characters, that the opportunity of seeing them in a wild state, even from the sea, must be deemed a privilege by the botanist.

Cape de Verd Islands.—The voyage, from the Canaries to the Cape de Verd Islands, generally presents a hiatus in the journals of those sea-faring naturalists who have followed this route. Before arriving at the Canaries, landsmen have scarcely recovered from the novelty of ship-board and its effects; nor has there been time, since leaving these islands, to become thoroughly inured to the monotony of a sailing life. At first sight, the Cape de Verd Islands are very disappointing. It is true that we had passed from an extra-tropical latitude to far within the tropics; but the change in position was not accompanied with a corresponding difference, still less with luxuriance, in the vegetation and scenery. Yet these apparently barren islands have associations of great interest; and their examination yields both pleasure and profit. They afford us the first glimpses of the fever-smitten coast of Africa, and of slavery. Even the black man here, deprived of freedom, and an alien to the land in which, though guiltless, he is a prisoner for life, is apt to be regarded as a mere object of natural history by his Caucasian fellow-creature; who, before he has time for reflection, may perhaps be excused for pausing to consider, whether a being so different in features and social position, be really of the same origin as himself; whether, in short, the poor African is a race of the same stock, or a species apart.

There are many other circumstances, connected with these islands, calculated to keep the mind busy while in their neighborhood. They form the western extreme of the Old World, of what was the whole world to civilized man, till within the last very few hundred years; and hence these, the North Cape and Cape of Good Hope, constitute the three salient points in the geography of the eastern Atlantic. In many of their physical features, they form a continuation of the great Sahara desert; that mysterious blank on our maps, upon whose sea of sand so many of our venturesome countrymen have embarked, to be heard of no more. The hitherto unexplored mountains rise eight thousand feet and upwards above the sea, in serried ridges and isolated peaks, promising a rich harvest to some botanist, who may in these higher and cooler parts of the islands rely on immunity from disease and on a temperate climate. There he may expect to find new types of plants; for the Mountain Flora of Western Tropical Africa is wholly unknown; and of its probable nature even we can form no guess. To conclude, the Linnæan axiom of "semper aliquid novi ex Africa" has never yet proved false. A naturalist cannot see the shores of that continent without feeling that no other spur is required to exertion, in a field to which such a motto still applies with so much force.

2. *On the fundamental type and homologies of the Vertebrate Skeleton;* by Prof. Owen, (from the Literary Gazette; Ann. Mag. Nat. Hist., xix, 202, March, 1847.)—The Professor commenced by alluding

to the origin of anatomy in the investigation of the human structure, in relation to the relief and cure of disease and injuries; and to the consequent creation of an anatomical nomenclature, having reference solely to the forms, proportions, likenesses and supposed functions of the parts of the human body; which were originally studied from an insulated point of view, and irrespective of any other animal structure or any common type. So, likewise, the veterinary surgeon had begun the study of the anatomy of the horse in an equally independent manner, and had given as arbitrary names to the parts which he observed. Thus, in the head of a horse there was the "os quadratum;" and in the foot the "cannon-bone," the "great" and "small pastern-bones," the "coronet," and "coffin-bones," &c. When the naturalist first sought to penetrate beneath the superficial characters of the objects of his study, their anatomy had often been conducted in the same insulated and irrelative way. The ornithotomist, or dissector of birds, describes his "ossa homoidea," "ossa communicantia" seu "interarticularia," his "columella," his "os furcatorium" and "os quadratum," the latter being quite a distinct bone from the "os quadratum" of the hippotomist. The anatomizer of reptiles described "hatchet-bones" and "chevron-bones," an "os cinguliforme" or "os en ceinture," and an "os transversum;" he had also his "columella," but which was a bone distinct from that so called in the bird. The icthyotomist described the "os discoideum," "os transversum," "os cœnosteon," "os mystaceum," "ossa simplectica," "prima," "secunda," "tertia," "quarta," &c. Each at first viewed his subject independently and irrelatively; and finding, therefore, apparently new organs, created a new and arbitrary nomenclature for them.

After pointing out the impediments to a philosophical knowledge of anatomy, from such disconnected attempts to master its complexities, and the almost impossibility of retaining in the memory such an enormous load of names, many distinct ones signifying the same essential part, whilst different parts had received the same name, Prof. Owen proceeded to demonstrate the principal results of the philosophical researches of Cuvier, and other comparative anatomists, in tracing the same or homologous parts through the animal series, as they were exemplified in the osseous system, and principally in the bones of the head. When any bones in the human skull, for example, had been thus traced and determined in the skulls of the lower vertebrate animals, the same name was applied to it there as it bore in human anatomy, but understood in an arbitrary sense; and when the part had no name in human anatomy, but was indicated, as often happened, by a descriptive phrase, it received a name having a close relation to such phrase; and thus a uniform nomenclature had arisen out of the investigation of the homologies of the bones of the skeleton, applicable alike to the human subject, the quadruped, the bird, and the fish. The corresponding parts have been sometimes called *analogues*, and sometimes *homologues;* the latter being the appropriate term, since the parts are in fact namesakes. The essential difference between the relations of *analogy* and *homology* was illustrated by reference to a diagram of the skeletons of the ancient and modern flying dragons. The wings of the extinct pterodactyle were sustained by a modification of the bones

of the fore-arm or pectoral limb, which bones were long and slender, like those of the bat; and one of the fingers, answering to our little finger, was enormously elongated. The wings of the little *Draco volans*, the species which now flits about the trees of the Indian tropics, were supported by its ribs, which were liberated from an attachment to a sternum, and were much elongated and attenuated for that purpose. The wing of the pterodactyle was *analogous* to the wing of the Draco, inasmuch as it had a similar relation of subserviency to flight; but it was not *homologous* with it, inasmuch as it was composed of distinct parts. The true homologue of the wing of the pterodactyle was the foreleg of the little *Draco volans*.

The recognition of the same part in different species, Prof. Owen called the "determination of a special homology;" the recognition of its relation to a primary segment of the typical skeleton of the vertebrata, he called the "determination of its general homology." Before entering upon the higher generalization involved in the consideration of the common or fundamental type, Prof. Owen gave many illustrations of the extent to which the determination of special homologies had been carried, dwelling upon those which explained the nature and signification of the separate points of ossification at which some of the single cranial bones in anthropotomy began to be formed; as in the so-called "occipital," "sphenoid," and "temporal" bones. More than ninety per cent. of the bones in the human skeleton had had their namesakes or homologues recognized by common consent in the skeletons of all vertebrate animals; and Prof. Owen believed the differences of opinion on the small residuum, capable with one or two exceptions, of satisfactory adjustment. The question then naturally arose in the philosophical mind, upon what cause or condition does the existence of these relations of *special homology* depend? Upon this point the anatomical world was divided. The majority of existing authors on comparative anatomy appeared either to have tacitly abandoned, or, with Cuvier and Agassiz had directly opposed, the idea of the law of special homologies being included in a higher and more general law of uniformity of type, such as has been illustrated by the theory of the cranium consisting of a series of false or anchylosed vertebræ. Profs. de Blainville and Grant, however, teach the vertebral theory of the skull; the one adopting the four vertebræ of Bojanus and the gifted propounder of the theory, Oken; the other regarding the hypothesis of Geoffroy St. Hilaire of the cranial vertebræ as more conformable to nature. Prof. Carus of Dresden has beautifully illustrated the poet Goethe's idea of the skull being composed of six vertebræ. But these authors had left the objections of Cuvier and Agassiz unrebutted; and judging from the recent works of Profs. Wagner, Müller, Stannius, Hallmann, and others of the modern German school, and those of Milne Edwards, the doctrine of unity of organization, as illustrated by the vertebral theory of the skull, seemed to be on the decline on the continent. To account for the law of special homologies on the hypothesis of the subserviency of the parts so determined to similar ends in different animals—to say that the same bones occur in them because they have to perform similar functions—involve many difficulties, and are opposed by numerous phenomena. Admitting that the multiplied

points of ossification in the skull of the human fœtus facilitate, and were designed to facilitate, child-birth, yet something more than a final purpose lies beneath the fact, that all these points represent permanently distinct bones in the cold-blooded vertebrata. And again, the cranium of the bird, which is composed in the adult of a single bone, is ossified from the same number of points as the human embryo, without any possibility of a similar final purpose being subserved thereby. Moreover, in the bird, as in the human subject, the different points of ossification have the same relative position and plan of arrangement as in the skull of the young crocodile; in which animal they always maintain, as in most fishes, their primitive distinctness. A few errors, some exaggerated transcendentalisms and metaphorical expressions of the earlier German homologists, and a too obvious tendency to *à-priori* assumptions and neglect of rigorous induction on the part of Geoffroy St. Hilaire, had afforded Cuvier apt subjects for the terse sarcasm and polished satire which he directed against the school of "Unity of Organization." The tone also which the discussions gradually assumed towards the latter period of the career of the two celebrated anatomists of the French Academy, seems to have led to a prejudice in the mind of Cuvier against the entire theory and transcendental views generally; and he finally withdrew, in the second edition of his 'Leçons d'Anatomie Comparée,' that small degree of countenance to the vertebral theory of the skull which he had given by the admission of the three successive bony cinctures of the cranial cavity in the 'Régne Animal.'

Prof. Owen then briefly alluded to the researches which he had undertaken, with a view to obtain conviction as to the existence or otherwise of one determinate plan or type of the skeletons of the vertebrata generally; and stated, that after many years' consideration given to the subject, he had convinced himself of the accuracy of the idea that the endo-skeleton of all vertebrate animals was arranged in a series of segments, succeeding each other in the direction of the axis of the body. For these segments or "osteocommata" of the endo-skeleton, he thought the term "vertebræ" might well be retained, although used in a somewhat wider sense than it is understood by a human anatomist. The parts of a typical vertebra were then defined, according to the views explained in the Professor's 'Lectures on Vertebrata;' and he proceeded to apply its characters to the four segments into which the cranial bones were naturally resolvable. The views of the lecturer were illustrated by diagrams of the disarticulated skulls of a fish, a bird, a marsupial quadruped, and the human fœtus. The common type was most closely adhered to in the fish, as belonging to that lower class of vertebrata in which "vegetative repetition"* most prevailed, and the type was least obscured by modifications and combinations of parts for mutual subservience to special functions. The bones of the skull were arranged into four segments or vertebræ, answering to the four primary divisions of the brain, and to the nerves

* The general principle of animal organizations, which Prof. Owen has termed "the law of vegetative or irrelative repetition," is explained in the first volume of his 'Hunterian Lectures,—on the Invertebrate Animals.'

transmitted to the four organs of special sense seated in the head. Prof. Owen adopted the names which had been assigned to these vertebræ from the bones constituting their neural spines, viz., occipital, parietal, frontal, and nasal; and enumerated them from behind forwards, because, like the vertebræ of the tail, they lose their typical character as they recede from the common centre or trunk. The general results of the Professor's analysis may be thrown into the following tabular form:—

Primary Segments of the Skull-bones of the Endo-skeleton.

VERTEBRÆ.	OCCIPITAL.	PARIETAL.	FRONTAL.	NASAL.
Centrums.	Basioccipital.	Basisphenoid.	Presphenoid.	Vomer.
Neurapophyses.	Exoccipital.	Alisphenoid.	Orbitosphenoid.	Prefrontals.
Neural Spines.	Supraoccipital.	Parietal.	Frontal.	Nasal.
Parapophyses.	Paroccipital.	Mastoid.	Postfrontal.	None.
Pleurapophyses.	Scapula	Stylohyal.	Tympanic.	Palatal.
Hæmapophyses.	Coracoid.	Ceratohyal.	Articular.	Maxillary.
Hæmal Spines.	Episternum.	Basihyal.	Dentary.	Premaxillary.
Diverging appendage.	Fore-limb or fin.	Branchiostegals.	Operculum.	Pterygoids & Zygoma.

The upper or neural arch of the occipital vertebra protected the *epencephalon*, or medulla oblongata and cerebellum; that of the parietal vertebra protected the *mesencephalon*, or third ventricle, optic lobes, conarium and hypophysis; that of the frontal vertebra the *prosencephalon*, or cerebral hemispheres; that of the nasal vertebra the *rhinencephalon*, or olfactory crura and ganglions.

The superior development of the cerebral hemispheres in the warm-blooded class, and their enormous expansion in them, occasions corresponding development of the neural spines, not only of their proper vertebra, but, by their backward folding over the other primary segments, of those of all the other vertebræ; whilst the more important parts of the neural arch, as the neurapophyses, undergo comparatively little change.

The acoustic nerve escapes between the occipital and parietal vertebræ, but the organ itself is intercalated between the neural arches of these segments and its ossified capsule; the petrosal projects into the cranial cavity between the exoccipital and alisphenoid in the warm-blooded vertebrata. The gustatory nerve (part of the third division of the fifth pair) perforates or notches the alisphenoid, and in crocodiles and many fishes passes through an intervertebral foramen between the alisphenoid and orbitosphenoid; but the gustatory organ is far removed from the neural arches or cranium proper, and is united with its fellow to form the apparently single organ called the tongue. The optic nerve perforates or grooves the orbitosphenoid, and the eyeball intervenes between the frontal and nasal vertebræ, as the earball does between the occipital and parietal: the vertebral elements are modified to form cavities for these organs of sense; that lodging the eye being called the "orbit," that for the ear the "otocrane."

The divergence of the olfactory crura, and the absence of any union or commissure between the olfactory ganglia, leads to an extension of ossification from their neurapophyses, which are always perforated by the olfactory crura or nerves, to the median line between those parts; and the neurapophyses themselves coalesce together there in batrachia, birds, and mammals. This extreme modification was to be expected

in a vertebra forming the anterior extremity of the series; and the typical condition of the prefrontals, so well shown in fishes and saurians, is marked in mammals by the enormous development of the capsules of the organ of smell anterior to them, which become ossified and partially anchylosed to the compressed, shrunken and coalesced prefrontals; the whole forming the composite bone called "æthmoid" in anthropotomy. The vomer, or body of the nasal vertebra, has undergone an analogous modification to that which the terminal vertebra of the tail presents in birds; whence its special name, referring to the likeness to a ploughshare, in human anatomy. The spine, or nasal bone, is sometimes single, sometimes divided, like the frontal, the parietal and the supraoccipital bones. Their special adaptive modifications have obtained for them special names.

The hæmal arches corresponding with the above neural arches retain most of their natural position and proportions, as might be expected, in fishes; they are called the scapular, hyoid, mandibular, and maxillary arches. The pleurapophysis of the occipital vertebra is the scapula, and is commonly attached by a head and tubercle to the centrum and parapophysis of its proper occipital vertebra.

The hyoid arch is suspended by the medium of the epitympanic to the mastoid parapophysis of the parietal vertebra, the epitympanic, in fishes, intervening and separating the hæmal arch from its proper vertebra, just as the squamosal intervenes to detach the tympanic pleurapophysis of the mandibular arch from its proper vertebra in mammals; which vertebra the squamosal attains in man by articulating with the process representing the coalesced postfrontal. In return, we find the hyoidean arch resuming its normal connexions in many mammalia, the stylo-hyal element being directly articulated to the mastoid: in man the large petrosal capsule intervenes, and contracts that anchylosis with the proximal or pleurapophysial element of the hyoid arch, which has led to the description of the stylohyal as a process of the temporal bone, in works on human anatomy.

In fishes, the tympanic, which is the true pleurapophysis of the mandibular arch, always articulates with the postfrontal, besides its accessory joint with the mastoid. The maxillary arch is articulated by its pleurapophysis, the palatine bone, with the centrum and neurapophysis (vomer and prefrontal) of the nasal vertebra. This is the normal and constant point of suspension of the maxillary arch; other accessory attachments to ensure its fixation and strength are successively superinduced upon this primary and essential one. Through this knowledge of the general homology of the palatine, an insight was gained into its singular disposition in man, creeping up, as it were, into the orbit, to touch the pars plana of the æthmoid; this secret affinity with the modified neurapophysis of the nasal vertebra becomes intelligible by a recognition of its relations to the general type of the vertebrate skeleton, by its determination as the rib or pleurapophysis of the nasal vertebra, and therefore retaining, as such, more or less of its essential connexion with the centrum (vomer) and neurapophyses (æthmoid or prefrontal) of the nasal vertebra throughout the vertebrate series.

The tympano-mandibular and the hyoidean arches had both been recognized as resembling ribs. A like homology of the scapula had early been detected by Oken; but its relation to the skull or occiput had been masked, and had escaped previous notice, by its displacement from its natural or typical connexions in all the air-breathing vertebrata.

The enunciation of these correspondences has sometimes been received by anatomists conversant with one particular modification of the general type, with as little favor as those of the "cannon-bone" to the metacarpus, of the "great and small pastern" and the "coffin-bones" to the digital phalanges of the human hand, may be supposed to have been by the earlier veterinarians.

Prof. Owen adduced instances of the displacement of different vertebral elements to subserve special exigencies, as that of the neurapophyses in the bird's sacrum, and that of the ribs of the human thorax, in which there could be, and had been, no question as to the reference of such displaced parts severally to their proper vertebral segments. The displacement of the scapular arch from the occiput was a modification of precisely the same kind, and differed only in degree. In the crocodile every cervical as well as every dorsal vertebra had its ribs; and in the immature animal the same elements existed, as distinct parts, in the lumbar, sacral, and in several caudal vertebræ. The occipital vertebra would be represented only by its "centrum" and "neural arch," unless the loose and obviously displaced scapulo-coracoid arch were recognized as its pleurapophysial and hæmapophysial elements. This arch made its first appearance in every vertebrate embryo close to the occiput; and in fishes—the representatives of the embryo-state of higher vertebrata, where the principle of vegetative repetition most prevailed, and the primitive type was least obscured by teleological or adaptive modifications—the scapular arch retained its true and typical connexions with the occiput.

The general homology of the locomotive members as developments of the diverging appendages of the inferior vertebral arches, was illustrated, and the parallelism in the course of the modifications of all such appendages pointed out. As the scapular arch belongs to the skull, so its appendages, the pectoral or anterior members, were essentially parts of the same division of the skeleton segments.

As a corollary to the generalization that the vertebrate skeleton consisted of a series of essentially similar segments, was the power of tracing the corresponding parts from segment to segment in the same skeleton. The study of such "serial homologies" had been commenced by the unfortunate Vicq. d'Azyr, in his memoir "on the parallelism of the fore and hind extremities;" and similar relations could be traced through the more important elements of the series of vertebræ. Prof. Owen believed it to be an appreciation of some of these homologies that lay at the bottom of the epithets, "scapula of the head," "ilium of the head," "femur of the head," &c., applied to certain cranial bones by Oken and Spix. To Cuvier this language had seemed unintelligible jargon; yet the error consisted merely in assigning a special instead of a general name to express the serial homology rightly discerned, in some of the instances, by the acute German anatomists.

"Scapula," "ilium," "rib," &c., were names indicative of particular modifications of one and the same vertebral element. Such element, understood and spoken of in a general sense, ought to have a general name. Had Oken stated that the tympanic bone of the bird, for example, was a "pleurapophysis" (or by any other equivalent term) of the head, his language would not only have been accurate, but intelligible, perhaps, to Cuvier. When Oken called it the "scapula of the head," he then unduly extended such special name, and transferred it to a particularly and differently modified pleurapophysis, which equally required to have its own specific name.

Professor Owen dwelt on the necessity of having clearly-defined terms for distinct ideas, in order to ensure the progress of science; and alluded to the advancement of human anatomy by accurate determinations of the general type, of which man's frame was a modification.

3. *On the Minhocão of the Goyanes;* by M. Auguste de Saint Hilaire, (Comptes Rendus, Dec. 28, 1846; Ann. Mag. Nat. Hist., xix, 140.)—Luiz Antonio da Silva e Souza, whose acquaintance I made during my travels, and to whom we owe the most valuable researches on the history and statistics of Goyaz, says, in speaking of the lake of Padre Aranda, situated in this vast province, that it is inhabited by minhocões; then he adds that these monsters—it is thus he expresses himself—dwell in the deepest parts of the lake, and have often drawn horses and horned cattle under the water. The industrious Pizarro, who is so well acquainted with all that relates to Brazil, mentions nearly the same thing, and points out the lake Feia, which is likewise situated in Goyaz, as also being inhabited by minhocões.

I had already heard of these animals several times, and I considered them as fabulous, when the disappearance of horses, mules and cattle, in fording the rivers, was certified by so many persons, that it became impossible for me altogether to doubt it.

When I was at the Rio dos Pilões, I also heard much of the minhocões; I was told that there were some in this river, and that at the period when the waters had risen, they had often dragged in horses and mules whilst swimming across the river.

The word *minhocão* is an augmentative of *minhoca*, which in Portuguese signifies *earth-worm;* and indeed they state that the monster in question absolutely resembles these worms, with this difference, that it has a visible mouth; they also add, that it is black, short, and of enormous size; that it does not rise to the surface of the water, but that it causes animals to disappear by seizing them by the belly.

When, about twenty days after, having left the village and the river of Pilões, I was staying with the Governor of Meiapont, M. Joaquim Alvez de Oliveira, I asked him about these minhocões: he confirmed what I had already been told, mentioned several recent accidents caused by these animals, and assured me at the same time, from the report of several fishermen, that the minhocão, notwithstanding its very round form, was a true fish provided with fins.

I at first thought that the minhocão might be the *Gymnotus carapa*, which according to Pohl is found in the Rio Vermelho, which is near to the Rio dos Pilões; but it appears from the Austrian writer that this

species of fish bears the name of *Terma termi* in the country; and moreover the effects produced by the Gymnoti are, according to Pohl, well known to the mulattos and negroes who often felt them, and have nothing in common with what is related of the minhocão. Professor Gervais, to whom I mentioned my doubts, directed my attention to the description which P. L. Bischoff has given of the *Lepidosiren;* and indeed the little we know of the minhocão agrees well enough with what is said of the rare and singular animal discovered by M. Natterer.

That naturalist found his *Lepidosiren* in some stagnant waters near the Rio da Madeira and of the Amazon: the minhocão is not only said to be in rivers, but also in lakes. It is, without doubt, very far from the lake Feia to the two localities mentioned by the Austrian traveller; but we know that the heats are excessive at Goyaz. *La Serra da Paranahyba e do Tocantim*, which crosses this province, is one of the most remarkable dividers of the gigantic water-courses of the north of Brazil from those of the south; the Rio dos Pilões belongs to the former, as does the Rio da Madeira. The *Lepidosiren paradoxa* of M. Natterer has actually the form of a worm, like the minhocão. Both have fins; but it is not astonishing that they have not always been recognized in the minhocão, if, as in the *Lepidosiren*, they are in the animal of the Rio dos Pilões reduced to simple rudiments. "The teeth of the *Lepidosiren*," says Bischoff, "are well-fitted for seizing and tearing its prey; and to judge of them from their structure and from the muscles of their jaw, they must move with considerable force." These characters agree extremely well with those which we must of necessity admit in the minhocão, since it seizes very powerfully upon large animals and drags them away to devour them. It is therefore probable that the minhocão is an enormous species of *Lepidosiren;* and we might, if this conjecture were changed into certainty, join this name to that of the minhocão to designate the animal of the lake Feia and of the Rio dos Pilões. Zoologists who travel over these distant countries will do well to sojourn on the borders of the lake Feia, of the lake Padre Aranda, or of the Rio dos Pilões, in order to ascertain the perfect truth—to learn precisely what the minhocão is; or whether, notwithstanding the testimony of so many persons, even of the most enlightened men, its existence should be, which is not very likely, rejected as fabulous.

4. *Ear of the Limnæus stagnalis*, (Weigm. Archiv.; L'Institut, March 10, 1847.)—According to observations by M. Frey, the auricular vesicle is visible in the Limnæus stagnalis soon after the rotary movements of the embryo have ceased and the animal has commenced to become coiled in the interior of its shell. There may then be easily observed in the interior part of the body, the rudiments of tentacles, the eyes with their pigment, and the tongue with its characteristic epithelium; and on each side of the base of the tongue, the auditive vesicles may be distinguished. These vesicles are spherical, with a simple contour, and have a diameter of $\frac{1}{60}$ to $\frac{1}{50}$ of a line (French). They appear at first to contain in the interior only a transparent liquid, and are then, like the eyes, without any connection with the central parts of the nervous system. But soon one or two small corpuscles are formed in the liquid interior, whose form, size, and oscillatory move-

ments are wholly similar to those of the otolites pertaining to the ears in the perfect animal. The size of these otolites varies from $\frac{1}{4}\frac{1}{5}\frac{1}{0}$ to $\frac{1}{3}\frac{1}{6}\frac{1}{0}$ of a line. The number increases gradually to twenty, when the animal quits its shell, and at this time the diameter of the vesicle is $\frac{1}{7}\frac{1}{0}$ of a line. They continue multiplying, and are one to two hundred in number in the adult, when the vesicle is $\frac{1}{1}\frac{1}{6}$ to $\frac{1}{7}\frac{1}{0}$ of a line in diameter. The development of the hearing apparatus is the same essentially in the Physa, Paludina, and other terrestrial Gasteropods. In bivalves, the vesicle contains only one otolite of large size, which fills the cavity of the vesicle.

IV. Astronomy.

1. *The Planet Neptune, and its Relations to the Perturbations of Uranus.*—In the Boston Courier of April 30, 1847, Prof. Benjamin Peirce, of Harvard University, announces the following conclusions:

"The problem of the perturbations of Uranus admits of three solutions, which are decidedly different from each other, and from those of LeVerrier and Adams, and equally complete with theirs. The present place of the theoretical planet, which might have caused the observed irregularities in the motions of Uranus, would, in two of them, be about one hundred and twenty degrees from that of Neptune, the one being behind and the other before this planet. If the above geometers had fallen upon either of these solutions, instead of that which was obtained, Neptune would not have been discovered in consequence of geometrical prediction. The following are the approximate elements for the three solutions at the epoch of Jan. 1, 1847:—

	I.	II.	III.
Mean longitude, - -	319°	79°	199°
Long. of perihelion, - -	148	219	188
Eccentricity, - -	0·12	0·07	0·16

In each of them (the mass of the sun being unity) the mass is 0·0001187. The period of sidereal revolution is double that of Uranus. It will be observed that the mean distance in all these cases is the same with that of Neptune, and that in the first of them, the present direction is not more than seven degrees from it; and in another solution which I have obtained, the present direction is almost identical with Neptune's. But the coincidence fails in a most important point; for, whereas Walker and Adams both demonstrate, from incontrovertible data, and a simple but indisputable argument, that the new planet cannot be more than 90° from its perihelion, either of these two latter geometrical planets would now be in aphelion and at much too great a distance from the sun.

"All my attempts to reconcile the observed motions of Neptune with the assumption that it is the principal source of the unexplained irregularities in the motions of Uranus, have been frustrated. Whatever orbit is attributed to this planet in my analysis, whether Walker's, or Valz's, or Encke's, or Adams's, or any other which I can suppose, and which is not unquestionably irreconcilable with observation; and whatever may be supposed to be its mass, I cannot materially diminish the amount of residual perturbation, but leave it full as great as it was previous to Galle's

discovery. Notwithstanding my repeated examinations, it would be presumptuous in me to claim for my investigations a freedom from error which the greatest geometers have not escaped, especially in the face of the vastly improbable conclusion to which my analysis tends, viz. that the influence of the new planet is wholly different from that demanded by the problem whose solution led to its discovery. It may however be asked whether the attraction of Uranus might not be exhibited in the motions of Neptune, in such a way as to modify the orbit deduced from observation, and thus to reconcile it with theory; but this question cannot be answered without further investigation."

Mr. Walker's important discovery of the identity of Neptune with a star observed by Lalande, May 10, 1795, (Vol. iii, ii Ser., p. 441,) seems now amply confirmed. An examination of the original observations of Lalande, shows that he also observed the body two days previous, but as the two observations disagreed, the earlier was rejected, and the latter marked doubtful. The following communication on the subject, by Mr. Walker, appeared in the National Intelligencer, (Washington,) of June 4, 1847.

Gentlemen,—In my letter of May 22d, announcing the confirmation of my discovery of the Lalande observation of Neptune, I remarked that the elements can now be completed, and that the computation of Neptune's perturbations would afford the means of obtaining the pure elliptic orbit round the sun from the perturbed orbit presented in elements V.

I have just completed this research by freeing them from the effect of the present action of the three great planets, (that of the others is nearly insensible,) and am now able to offer to the public the definitive elements of Neptune's orbit. They are as follows, referred as before to the mean equinox of January 1, 1847, and to mean noon Greenwich:

Elements VII. of Neptune, completed June 1st.

Perihelion point,	1° 45′ 32″·90
Ascending node,	129 51 13 ·53
Epoch, January 1, 1847,	326 2 1 ·34
Inclination,	1 45 38 ·10
Eccentricity,	0·005052917
Mean distance,	30·17775
Mean daily sidereal motion,	21″·41144
Period in tropical years,	165y·7175

Elements VII. are derived entirely from the planet's recent path for nine months. The test of their correctness is, that they should represent within reasonable limits the two observations of Lalande of May 8th and May 10th, 1795. The great pains bestowed on the reduction of these observations of Lalande, by M. Victor Mauvais of the Institute of France, induce me to adopt his places of Neptune for those dates as published in the *Comptes Rendus* for 1847, No. 16. I have referred them to the mean equinox of January 1, 1847. I have corrected them for parallax, but not for aberration, and have compared them with my ephemeris from Elements VII. The result is as follows:

Comparison with Lalande's Observations.

Date, 1795. Mean time, Paris.	Lalande's two observations of Neptune.		Correction of Ephemeris VII.	
	R. A.	Dec.	R. A.	Dec.
h. m. s.				
May 8th—11 10 57 .	213° 41′ 3″·89	South 11° 35′ 4″·96	+141″·1	+39″·5
May 10th—11 2 55 .	213 38 5 ·16	South 11 34 5 ·64	+147 ·8	+36 ·4
Observed motion in two days,	178″·73	59″·32		
Computed do. Elements VII,	185 ·42	62 ·38		
Discrepancy, . .	6″·6	3″·06		

The small difference of three minutes of arc between theory and observation for 1795, may be ascribed to the perturbations for that date, and for the fifty-two years' interval, which have been neglected.

The tropical period falls short by nearly a year of that which Professor Peirce has pointed out as necessary, in order that the Laplacian Libration should take effect. It is quite possible that a more full discussion of the perturbations may show the necessity of the Libration.

The eccentricity of Venus is 0·007, the smallest before known; that of Neptune is 0·005.

Hence it appears that the orbit of Neptune approaches nearer to a perfect circle than that of any other planet. I regard this value of the eccentricity of Neptune as conclusively established, and with this view will quote from LeVerrier's communication made to the Institute of France on the 29th of March last on the occasion of announcing my discovery. M. LeVerrier remarks:

"We confine ourselves for the present to the remark that this smallness of the eccentricity, which would result from the calculations of M. Walker, would be incompatible with the nature of the perturbations of the planet of Herschel. But it may be that this smallness of eccentricity is not a necessary consequence of the representation of Lalande's observation."

While I feel myself honored by the notice taken of my labors by the French astronomers, I think it just to express my full belief that when they have bestowed on its present orbit the same pains as myself, they will agree with me that this smallness of eccentricity is an unavoidable consequence of the direct observations.

If we admit for the moment that my views are correct, then LeVerrier's announcement of March 29th is in perfect accordance with that of Professor Peirce of the 16th of the same month, viz. that the present visible planet Neptune is not the mathematical planet to which theory had directed the telescope. None of its elements conform to the theoretical limits. Nor does it perform the functions on which alone its existence was predicted, viz. those of removing that opprobrium of astronomers, the unexplained perturbations of Uranus.

We have it on the authority of Professor Peirce that if we ascribe to Neptune a mass of three-fourths of the amount predicted by LeVerrier, it will have the best possible effect in reducing the residual perturbations of Uranus below their former value; but will nevertheless leave them on the average two-thirds as great as before.

It is indeed remarkable that the two distinguished European astronomers, LeVerrier and Adams, should, by a wrong hypothesis, have been led to a right conclusion respecting the actual position of a planet

in the heavens. It required for their success a compensation of errors. The unforeseen error of sixty years in their assumed period was compensated by the other unforeseen error of their assumed office of the planet. If both of them had committed only one theoretical error, (not then, but now believed to be such,) they would, according to Prof. Peirce's computations, have agreed in pointing the telescope in the wrong direction, and Neptune might have been unknown for years to come. Yours, respectfully, SEARS C. WALKER.

Washington, June 1, 1847.

V. MISCELLANEOUS INTELLIGENCE.

1. *Facts in Physiological Chemistry;* by J. LIEBIG, (from a letter addressed by Baron von Liebig, to President Everett, of Harvard University.)—I ought several months since to have replied to your letter communicating the interesting intelligence in relation to the action of the vapor of ether. The result of your letter to me, you have doubtless seen in the European papers. The world is filled with the magnitude of this discovery, and we are looking for the most important applications of it in surgical practice. It is a benefaction to suffering humanity, when painful operations, through a medium so simple and safe, can be performed with diminished pain; and the world is most deeply indebted to the man who first employed ether for this purpose.

I have long intended to write in acknowledgment of your friendly letter; but I desired by way of return to incorporate in reply the results of an investigation, which has been brought to a conclusion only within the last few days. It is a chemical investigation of muscle-flesh; in which I have been led to some interesting results.

The fluid in the meat of recently slaughtered animals—the *flesh-fluid*—is *sour* and contains two free acids, whose nature up to this time has been but imperfectly known. I have found that one of the acids is an *organic acid*, and is the same that appears in the process of the souring of milk. The other acid is phosphoric acid. Both acids are but partially free. A part is united to potash, magnesia and lime. They have been recognized in all muscle-flesh thus far examined, as well of carnivorous as of herbivorous animals.

A second ingredient, which I have found in all kinds of flesh, is a crystalline body, which was discovered in broth by Chevreul, eleven years ago, and described by him under the name *Creatine*. It was supposed, inasmuch as Berzelius could find nothing in the fluid expressed from flesh, that this was an accidental ingredient. But this opinion rested upon an error. Creatine is found in the flesh of all healthy animals.

The composition of the body is such that creatine may be regarded as a compound of the body, *Glycocoll*—so accurately studied by Mr. Horsford—and ammonia.*

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* *Note from Prof. Horsford.*—One atom of creatine equals two atoms of glycocoll and one atom of ammonia.

$$C_8H_{11}N_3O_6=2(C_4H_4NO_3)+NH_3.$$

It contains also the elements of urea, glycocoll and wood-spirit.

$$C_8H_{11}N_3O_6=C_2H_4N_2O_2+C_4H_4NO_3+C_2H_3O.$$

Liebig, by boiling creatine a length of time with baryta, separated the urea (doubtless as carbonic acid and ammonia;—$C_2H_4N_2O_2+2HO=2CO_2+2NH_3$,)

A third ingredient which is never wanting in fresh meat is a positive organic base of constitution analogous to that of *chinin*, or perhaps more nearly to that of *codein*, which is found in opium. There are also in meat two nitrogenous acids;—altogether, a variety of bodies whose existence in the living body could have been scarcely suspected. I have described these bodies and their chemical relations in a paper which is now in press, and will detail only a few results that may be practically applied.

The presence of two fluids throughout the body of opposite chemical nature, one acid, (the flesh-fluid,) the other alkaline, (the blood and lymph), separated from each other by membranes permeable to both, must satisfy any one that in this arrangement there is a source of electricity or of an electric current. I will not herewith say, that, by consequence, electrical effects must be recognizable in the body, for we know that these as such (electrical) disappear when through any result of motion, or chemical action (decomposition or composition) is produced, and I regard the latter as dependent upon an electrical stream.

Moreover, the occurrence in flesh of creatine,—of a substance whose properties are allied to those of the active ingredient of coffee (caffeine), as also of another which has all the properties of an organic base, makes the action of medicines appear no longer so dark and mysterious. The most efficient of all medicines from the vegetable kingdom are organic bases.

If you leach finely chopped meat with cold water, you procure a red fluid and a white residue. The latter is the actual muscular fibre, and the solution contains, beside the above named bodies, a considerable quantity of albumen that may be separated as coagulum by heating the fluid to boiling.

I have found that the residue (the muscular fibre) either for itself or boiled with water is tasteless, and that the water in which the fibre has been boiled derives no taste. The fibre, by boiling, becomes hard and altogether unpalatable.

All the ingredients having odor or taste, may of course, be abstracted with cold water. They are contained in the flesh-fluid of slaughtered animals.

You will not wonder, my most Respected Sir, if I now turn to receipts for the kitchen.

It follows from the above, that one can make for himself, in a few minutes, the best and strongest broth (Fleisch-brühe, Bouillon de viande): if, e. g. a pound of finely chopped beef (mince) with a pound (pint) of *cold* water, be carefully mixed and then slowly heated to boiling, and the fluid separated from the solid parts by pressing through clean cloth. This broth, with the usual condiments—(broiled onions, vegetables, salt, etc.) added, will furnish a dish beyond the criticism of the most fastidious gourmand.

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and there remained the organic base, mentioned in the paragraph which follows above. Its constitution, as given in a letter to Gay Lussac, and published in the Comptes Rendus for Feb. 6, is $C_6H_7NO_4$—and contains the elements of the Lactamide of Pelouze, a product of the action of dry ammonia gas upon lactic acid,—$C_6H_4O_4+NH_2$. It contains also the elements of Glycocoll and wood-spirit, as above intimated.

$$C_6H_7NO_4=C_4H_4NO_3+C_2H_3O.$$

Longer boiling will *not* necessarily make the extract stronger.

If the broth be slowly evaporated over a water bath, it will become brown, and assume a fine taste like broiled meat. If evaporated (by exceedingly gentle heat) to dryness, it yields a brown mass, of which, upon a journey, for example, half an ounce would convert a pound (pint) of water into the strongest broth.

By boiling a piece of meat in the water, a separation of the solution from the insoluble ingredients takes place. The soluble ingredients go into the extract—the broth—the soup. Among these beside those bodies mentioned above, are the alkaline phosphates. The thoroughly boiled meat contains no alkaline phosphates.

Now as these salts are necessary for the formation of the blood, it is clear that the fully boiled* meat, by the loss of them, loses its capacity to become either blood, or through blood to become flesh: *it loses its nutriment when eaten without the juices—the extract.*

In the extract the materials for the formation of albumen and fibrin, are both wanting. *Alone* also, it is not nourishing. Both must be eaten together. *The method of roasting is obviously the best to make flesh most nutritious.* But as the extract—the broth,—contains *all the ingredients of the acid gastric juice*, it may perhaps be the best agent to aid the process of digestion in cases of dyspepsia.

Finally, I have found that the brine which forms in the salting of meat, contains all the ingredients of the flesh-fluid. The composition of salted meat is essentially different from that of fresh meat—inasmuch as phosphoric acid, lactic acid, and the salts of these acids—together with creatine and creatinine are abstracted by being packed down in salt. The salted meat becomes partly reduced by this process to a mere supporter of respiration.† This may be a source of scrofula, where, by eating salt meat, the replacement of the wasted organism is but imperfectly effected—where it loses its constitution without regaining it from the food.

The temperature in the interior of a piece of meat to be boiled or roasted, rarely exceeds 100° C. (= 212° F.) The meat is done and palatable when it has been exposed to a temperature of 62° C. (144° F.), but it is in this condition, red like blood. The blood-red places—the undone portions,—were subjected at the highest to a temperature only of 60° C. (= 140° F.) At 70° to 72° C. (= 158° to 162° F.) all these places disappear. At 100° C. (= 212° F.) the fibre breaks up and becomes harder. The crusty property of the meat in chewing, depends upon the quantity of albumen, which, in a coagulated condition, permeates the fibre. The flesh of old animals is deficient in albumen.

If a piece of meat be put in *cold* water, and this heated to boiling, and boiled till it is "done," it will become harder and have less taste, than if the same piece had been thrown into water already boiling. In the first case the matters grateful to the smell and taste, go

* By this term it is intended to convey the idea of boiled till no further change occurs, or nothing more is extracted.

† Liebig divides food into two kinds. One serves in the formation of tissues; the other burns to sustain animal heat—as sugar and fat. The latter supports respiration.

into the extract—the soup; in the second, the albumen of the meat coagulates from the surface inward, and envelopes the interior with a layer which is impermeable to water. In the latter case the soup will be indifferent, but the meat delicious.

Giessen, 24th March, 1847.

2. *Inhalation of Ether*, (L'Institut, March 10, 1847.)—Experiments on the inhalation of ether by animals, have been extensively prosecuted in Paris, and have led to interesting results. M. Flourens observes from his investigations, that ether acts first upon the cerebrum, and disturbs the intellect; then upon the cerebellum affecting the equilibrium of movement; next upon the spinal cord, when it extinguishes successively sensibility and the power of motion, and finally upon the medulla oblongata, when it extinguishes life. In his late experiments, the action of ether has been pushed to the extinction of life.

M. Flourens, in order to compare the effects with those of asphyxia, subjected two dogs to the simplest kind of asphyxia produced by the gradual consumption of the oxygen contained in a given volume of atmospheric air. When the asphyxia had reached the required point, the spinal marrow, exposed, showed no signs of feeling when cut or lacerated, and only feeble muscular contractions on pinching the motor portion. M. Flourens hence infers that there is a marked analogy between etherization and asphyxia. But in ordinary asphyxia, the nervous system loses its forces under the action of the black blood, the blood deprived of oxygen; and in etherization this takes place, at first, under the quiet influence of the singular agent to which it is subjected.

3. *Gun-Cotton;* M. Schönbein's Patent, (Mechanics' Magazine; Mining Journal, April 10, 1847.)—The specification of this patent (taken out in the name of Mr. John Taylor, of the Adelphi) became due, and was enrolled on the 8th inst. The following is a correct abstract of its contents:—The patentee states, that the invention consists in the manufacture of explosive compounds applicable to mining purposes and to projectiles, and as substitutes for gunpowder, by treating and combining matters of vegetable origin with nitric and sulphuric acids.

The matter of vegetable origin which he prefers, as being best suited for the purposes of the invention, is cotton, as it comes into this country, freed from extraneous matters; and it is stated to be desirable to operate on the clean fibres of the cotton in a dry state.

The acids are—nitric acid of from 1·45 to 1·50 specific gravity, and sulphuric acid of 1·85 specific gravity.

The acids are mixed together in the proportion of one measure of nitric acid to three of sulphuric acid, in any suitable or convenient vessel not liable to be affected by the acids. A great degree of heat being generated by the mixture, it is left to cool until its temperature falls to 60° or 50° Fahr. The cotton is then immersed in it, and, so that it may become thoroughly impregnated or saturated with the acids, it is stirred with a rod of glass or other material not affected by the acids. The cotton should be introduced in as open a state as practicable. The acids are then poured or drawn off, and the cotton gently pressed by a presser of glazed earthen ware to press out the acids, after which it is covered up in the vessel, and allowed to stand for about an hour. It is

subsequently washed in a continuous flow of water, until the presence of the acids is not indicated by the ordinary test of litmus paper. To remove any uncombined portions of the acids which may remain after the cleansing process, the patentee dips the cotton in a weak solution of carbonate of potash, composed of one ounce of carbonate of potash to one gallon of water, and partially dries by pressing, as before. The cotton is then highly explosive, and may be used in that state, but, to increase its explosive power, it is dipped in a weak solution of nitrate of potash; and, lastly, dried in a room heated by hot air or steam to about 160° Fah. It is considered probable that the use of the solutions of carbonate of potash and nitrate of potash may be dispensed with, although actual experience does not warrant such an omission.

The patentee remarks, that nitric acid may be employed alone in the manufacture of explosive compounds; but that, as far as his experience goes, the article, when so manufactured, is not so good and far more costly.

When used, care should be taken to employ a much less quantity by weight, to produce the same result, than of gunpowder; and it has been found that three parts by weight of the cotton produce the same effect as eight parts by weight of the Tower-proof gunpowder. The cotton, when prepared in the manner before mentioned, may be rammed into a piece of ordnance, a fowling-piece, or musket; or may be made up into the shape of cartridges; or may be pressed, when damp, into moulds of the form of the bore of the piece of ordnance for which it is intended—so that, when dried, it shall retain the required figure; and it may also be placed in caps, like percussion caps, and made to explode by impact. Lastly, the patentee states, that although he prefers the use of cotton, other matters of vegetable origin may be similarly treated with acids to form an explosive compound, and that acids of an inferior specific gravity may be employed.

The patentee having thus described the nature of the invention, and in what manner the same is to be performed, states, that he does not confine himself to any of the details above specified, so long as the peculiar character of the invention is retained—viz., the manufacture of explosive compounds from matters of vegetable origin by means of acids. But, to adopt the patentee's own expression—"What I claim, is the manufacture of explosive compounds from matters of vegetable origin by means of nitric acid, or nitric and sulphuric acids."

4. *Experiments on the use of Gun-Cotton for blasting—its value compared with that of blasting Powder;* by Thomas B. Adams.—The difficulties to be surmounted in ascertaining the relative values of the new and old explosives are neither few nor small. Different qualities of powder are used in different quarries. That which is made in the same mill will produce different effects according to its chemical proportions, and its coarse or fine graining; powder of the same grain will act differently upon different kinds of rock. The powder used for blasting is the coarsest and slowest burning variety.

Gun-cotton is uniform in strength, and fires quicker than the finest gunpowder.

The rock is variable in texture, and liable to be crossed by seams which, if they be slight, may destroy the correctness of the result without being discovered by the operator.

The difference in the action of the two agents, that of the powder being slow, that of the cotton sudden, the imperfections of the mass upon which they act, are causes which render useless many comparisons and weaken our confidence in inferences drawn from a small number of experiments. Great care was taken in the experiments described below, to compare fairly the two explosives.

The gun-cotton was prepared with the strongest acids of commerce; sulphuric, sp. gr. 1·85; nitric, sp. gr. 1·49; time of immersion about twenty minutes. After the superfluous acid was thoroughly removed or neutralized, the cotton was immersed in one of the oxygenating solutions described by Prof. Schönbein, and dyed a light straw color. In short, it was the article of commerce, prepared by Messrs. C. & F. Lennig of Philadelphia, who are patentees of gun-cotton for the United States. A sample accompanies this note.

In May last the writer entered the collieries at Pottsville, Pa., examined and measured the bores in which the blasts were to be discharged, obtained and weighed the quantity of powder intended for each blast; (and upon examination it was found that the miners almost universally underrated the weight of their charges of gunpowder from 33 to 100 per cent.) and carefully noted. on the spot, all the circumstances alluded to in the table below. In noting the *effect*, the opinion of the miners themselves is given. When the results were better than were expected from the proposed charge of powder, they were marked *superior*. When less, *moderate;* and when equal, *good*.

The following extract from the tables is believed to be a fair sample of the whole. In every instance the writer was present during the charging, and discharging of the blasts, and all were made at least 500 feet below the surface.

Extract from Table of Experiments.

No. of discharge.	Kind of explosive.	Rock.	Depth of bore.	Diameter of bore.	Material of cartridge powder.	Depth allowed for powder.	Depth occupied by cotton.	Weight of powder.	Weight of cotton	Effect.	Smoke.	Vitiation.
			Inch.	Inch.		Inch.	Inch.	Oz.	Oz.			
3	C.	tough slate with iron ore,	18	1½	paper	. .	6	9¾	1	good	none	none.
4	C.	"	16	1¾	"	. .	6	9¾	1	good	none	none.
5	powd.	"	18	1¾	. .	. .	. .	6	.	mod.	dense	considerable.
7	"	"	15½	1¾	. .	5	. .	.	.	mod.	dense	considerable.
8	C.	"	17	1¾	. .	8	6	10	1½	sup.	none	none.
9	C.	red ash coal,	45	1½	. .	19	16	18¼	2¼	sup.	"	"
10	C.	"	27	1½	paper	12	10	9¼	1¼	"	"	"
12	C.	white ash coal,	36	1½	"	10	6	10	1	good	"	"
13	C.	"	36	1¼	"	14	6	13⅜	1¼	mod.	"	"

June 7, 1847.

5. *Pyroxyline*, (Comptes Rendus, March 8, 1847.)—MM. Flores Domonte and Menard, on submitting gun-cotton to alcoholized ether, obtained an incomplete solution; and on analysis the part dissolved gave the formula $C_{12}H_8O_8+2NO_5$, (that of Xyloidine according to these authors,) and the insoluble, the formula $C_{12}H_9O_9+3NO_5$. The

two added together, make $C_{24}H_{17}O_{17}+5NO_5$, Pelouze's formula for pyroxyline.* With cane sugar, glucose, mannite, sugar of milk, dextrine, and gum, analogous fulminating compounds have been formed by these chemists. They have succeeded in crystallizing the nitric mannite, and obtained for it the formula $C_{12}O_7H_7+5NO_5$.

6. *Process for Photographs upon paper;* by M. BLANQUART-EVRARD, (Comptes Rendus, Jan., 1847.)—This process is in part a modification of the Calotype, and is, according to its author, susceptible of many variations. The principles upon which it depends, are, 1st, the thorough impregnation of the paper by the photographic agent, so that the image is formed within the paper; and 2d, the perfection of surface given to a moist paper by placing it upon a glass, which, in the camera, is turned toward the lens, the image being formed on the wet surface of paper in contact with the glass.

As this process seems to be more simple than any other, and within the reach of persons of moderate skill, we give it somewhat in detail. For the first or negative proof, the very best letter paper is to be taken; its texture should be close and uniform; the surface very smooth. This paper is to be floated on the surface of a solution of one part nitrate of silver in thirty parts distilled water, observing the usual precautions of not including air bubbles, &c. After one minute the paper is removed, held up to drain by a corner, and then laid upon some impermeable surface and allowed to dry slowly.

Another solution is prepared of 25 parts iodid of potassium, 1 part bromid of potassium, and 560 parts distilled water. In this solution the paper is entirely immersed, with the silver side up, and suffered to remain from one and a half to two minutes, according to the temperature; it is then carefully withdrawn, holding it by two corners, and placed in a large vessel full of pure water; it is next hung up to dry upon a string, being fastened by one corner.

Paper thus prepared should be protected from the light and preserved in a pasteboard case, but not packed too closely. It will keep for months. The solutions kept in vessels covered by opaque paper may be used to exhaustion.

To take a proof, a smooth glass is made quite level upon a suitable support, and upon it are poured a few drops of a solution of 6 parts nitrate of silver, 11 parts crystallizable acetic acid, and 64 parts distilled water; (half of the water should be taken to dissolve the nitrate, and the remainder added about an hour after the acid has been mixed with the first portion.)

The paper is next to be applied to this liquid on the glass, the nitrated side downwards, and smoothed by the hand until there is a perfect contact with the glass without any folds or bubbles. One or more pieces of moist paper, according to the thickness, are then to be placed upon this; next a second glass of the same size, and the whole being properly secured, is used in the camera as a daguerreotype plate. The time of exposure varies according to the temperature, and is about one-fourth that required for plates prepared with chlorid of iodine.

* In Vol. iii, p. 295, there is an error arising from including with the formula of pyroxyline, the 8HO, which is separated in the process of formation.

When taken from the camera the proof is to be placed upon a plate of glass or porcelain, which has been slightly moistened in order that the paper may adhere to it. A saturated solution of gallic acid being poured over the proof, the image appears at once. The acid is allowed to act until all the details are brought out, but not until the white portions are discolored; to prevent this, the acid is removed by pouring a large quantity of pure water over the proof, which is finally entirely covered by a solution of 1 part bromid of potassium in 40 pts. distilled water. The paper remains in this last solution for a quarter of an hour, and is then well washed with clean water and dried between sheets of filtering paper. To render this negative impression more transparent, for the purpose of copying, a little wax may be scraped upon it and melted by a hot smoothing iron, some sheets of letter paper being placed between.

The paper for the positive proof should be very stout and as smooth as possible. Prepare a solution of 3 parts water saturated with common salt and 10 pts. distilled water; upon this float the paper for two or three minutes, and then dry it as much as possible by absorbent paper; and next float it upon a solution of 1 part nit. silver and 5 pts. water, until another sheet having undergone the previous process is ready to take its place; it is then to be removed, drained, and dried as before directed. In this way a quantity may be prepared in a short time. The positive paper is to be preserved in the way directed for the other, but must not be kept more than one or two weeks, or it will lose its delicacy and become discolored.

The positive proof is made by the usual process, the expose being as far as possible to the direct sunlight; about twenty minutes being the average time.

To fix this proof, it is to be taken into a darkened apartment, soaked for fifteen minutes in pure water, and then put into a solution of 1 part hyposulphate of soda and 8 pts. distilled water. It may now be examined by daylight, and the action of the hyposulphate watched. Gradually the lights become more brilliant, and the shades pass from a dirty red to a bistre and finally come to resemble those of an aquatint. When the desired tint is reached, the operation is stopped and the salt removed by soaking in water for five or six hours to a whole day. Several proofs can be immersed at the same time in the hyposulphate, and those which do not stand its action for two hours must be rejected. The operations although in appearance complicated, are in reality quite simple and of easy execution. G. C. S.

7. *Report on the Aurora Borealis.—Aurores Boréales*, 1 vol., 8vo. Accompagné d'un Atlas de 12 planches in folio; par MM. Lottin, Bravais, Lilliehöök, et Siljeström.*

The following notice of this great work is from M. Bravais. He remarks:—

I have divided my general review of the subject into eight paragraphs. In the first, I examine the much controverted question, as to the nature

* This is one of a series of twenty-six volumes of large 8vo, and seven folio atlases, published as the results of "Voyages de la Commission Scientifique du Nord, en Scandinavie, en Laponie, au Spitzburg et aux Feröe, pendant les années

of the dark segments lying generally below the auroral arches, or at their base. This segment, according to some, is merely an effect of contrast; according to others it is something material, (or real,) but independent of the aurora, caused perhaps by the polar fogs; and others consider it the generating source of the auroral light. I next show, that the light cannot be an effect of reflection, except in rare cases, and actually exists where it is observed.

In the second paragraph I consider the forms and portions of arches, their movements, light, and apparent structure. According to Hansteen, an auroral arch is a luminous ring situated in the upper regions of the atmosphere, sustained in all its parts at the same height, above the earth's surface, and whose axis corresponds nearly with the magnetic axis of the globe. Such a ring ought to appear more or less elevated above the horizon according to the position of the observer, and it ought to be seen to cut the plane of the magnetic meridian at right angles. The hypothesis of Hansteen, which is altogether the most probable, has been made the basis of our investigations with regard to the orientation, the height, and the amplitude of the arches. I understand by amplitude, the angular distance between the east and west sides measured on the plane of the horizon and on the north sides of the sky. At Bossekop, the summit of the arc is not only eight to ten degrees to the left of the *magnetic north*, but the deviation goes on increasing as the arch rises from the north toward the zenith and from the zenith to the south. The amplitude increases quite regularly during this movement of the arc. It does not become one hundred and eighty degrees until the arch has passed the zenith to the southern part of the sky.

It also results from our observations, that the curve of the arch is very similar to that of a small circle of the celestial sphere. This small circle projected upon the vertical plane which contains the culminant point of the arch is a straight line; and I show that on approaching the horizon, this right line becomes a hyperbolic curve though scarcely appreciable, and important only in a theoretical point of view, from its connection with the theory assumed.

From the simultaneous variation of the heights and amplitudes, (adopting the theory of Hansteen,) I have found the mean elevation above the earth to be 227 kilometers, (140 miles Eng. statute,) which corresponds to the upper limits of our atmosphere, or the region of falling stars, &c.

The third paragraph is devoted to the rays of the aurora borealis. The rays (streamers) are columns of light suspended in the air; they undergo rapid movement or changes, and appear to converge towards the magnetic zenith, where they thus form what is called the corona.

1838, 1839 et 1840, sur la corvette La Recherche commandée par M. Fabvre, Lieut. de Vaisseau; publiés par ordre du Roi sous la direction de M. Paul Gaimard, President de la Commission Scientifique du Nord." They include Reports on Astronomy, Pendulum Observations, Hydrography, Tides, 1 vol.; Meteorology, 3 vols.; Terrestrial Magnetism, 2 vols.; Aurora Borealis, 1 vol.; Geology, Mineralogy, Metallurgy, and Chemistry, 2 vols.; Botany, Physical Geography, Physiology, and Medicine, 2 vols.; Zoology, 3 vols.; History of Scandinavia and its Literature, and History of the Voyage, 4 vols.

With reference to the relation between the column and the arches, I have shown, in discussing our observations on partial corona, that even when the rays appear isolated and independent, they have a general arrangement in files or ranges, parallel to the direction of the arches. I have also shown a tendency in the arches to dissolve into columns; whence it is obvious that the simple ray is the result of an arrangement of the auroral light in lines parallel to the dipping needle. The arched form results from this, that if two rays exist simultaneously, they tend to place themselves so that their common place shall be perpendicular to the magnetic meridian, as if the equilibrium of two rays were not stable except in this position. But how this condition of stability is consistent with the idea that the rays have an electric nature and origin, is yet enveloped in mystery.

The luminous currents, exhibited in the ranges of columns, passing either from the east to the west or the reverse, are not equally frequent in the different directions; the same remark applies to the modes of progression in the arches from the north to the south and from the south to the north. I state the facts on this subject without pretending to offer any explanation.

We have observed the extra-zenith corona so frequently, as to be able to affirm that the coronas may appear in all possible directions in relation to the observer, and that their connection with the magnetic zenith is a simple result of linear perspective.

In the fourth paragraph I have treated of the auroral sheets. They are allied to the rays, but differ in their flickering or palpitating light and also in appearing only at a later hour of the night.

The fifth paragraph relates to the colors of the auroral light, which are less varied than generally supposed; for but three or four distinct shades were observed by us.

In the sixth paragraph I consider the facts which may lead the observer to suppose that the aurora is situated but a small distance from him. Although believing that their appearances are mostly deceptive, I do not affirm that all observations of this kind hitherto made are necessarily incorrect. I next treat of a resemblance, between the mean orientation of cirro-cumuli clouds in parallel bands optically convergent, and auroral arches.

In order to determine the altitude of auroral arches, M. Lottin and myself observed simultaneously, at opposite extremities of a base of 16 kilometers (10 miles); and we arrived at the result that the height at least exceeded 50 kilometers (31 miles). A longer base is necessary for a more precise determination. For such investigations, the base line should be about 100 kilometers long (60 miles), and in the direction of a terrestrial magnetic meridian.

The last paragraph contains general remarks on the frequency of the phenomena, its duration, hour of appearance, its possible continuance during a succession of days. I show that the progressive movements of the arches are wholly independent of the motion of the earth, which sets aside any theory founded on the idea of the cosmical origin of the Aurora, and sustains the view that it belongs to our atmosphere and almost exclusively to its upper regions.

8. *Hieroglyphical Mica Plates from the Mounds;* by E. Geo. Squier, (in a letter to Prof. Silliman.)—You have probably observed a paragraph, going the rounds of the newspapers, credited to a journal published at Lower Sandusky in this state, to the effect that a number of inscribed plates of mica were recently discovered, in excavating an ancient mound near that place. These plates are represented, in the account, as oval in shape, measuring seven by ten inches, and "covered with *hieroglyphics* of different and beautiful colors, betokening a more advanced and entirely different state of the arts than has heretofore been discovered in the remains of the Indian tribes!" As this announcement has created some degree of interest, and elicited some inquiries, it will not be out of place to observe, that one of the plates has been placed in our hands, through the kindness of a friend, residing at the point mentioned. The form of the plates and their size are correctly represented, but the hieroglyphics are nothing more nor less than *discolorations* caused either by the infiltration of a mineral solution between the laminæ, or by its presence at the period of crystallization. The material is very well known as *graphic* or *hieroglyphic mica*, a deposit of which occurs upon the Schuylkill, not far above Philadelphia. Although the discoloration, following the planes of crystallization, falls, in places, into right lines, it seems utterly unaccountable that they were mistaken for the work of man! This is another illustration of the very loose manner in which facts relating to our antiquities have been placed before the world:—a looseness, unfortunately, not entirely peculiar to newspaper statements. The plates are very pretty specimens of the mineral, and are each perforated, near one of the ends, with a small hole. They were undoubtedly used for purposes of ornament. Mica is common in the mounds, sometimes cut into the form of scrolls and other ornamental plates. I have taken a bushel of the sheets from a single mound.

9. *Water-Power of Europe*, (Mining Journal, April 10, 1847.)—A curious communication has been addressed to the Paris Academy of Sciences, from M. Daubrée, containing a calculation of the quantity of heat annually applied to the evaporation of the water on the surface of the globe, and of the dynamic force of the streams of continents. He finds that the evaporation employs a quantity of heat about equal to one-third of what is received from the sun; or, in other words, equal to melting a bed of ice of nearly thirty-five feet in thickness, if spread over the globe. The motive force of the streams in Europe is, according to M. Daubrée, equal to between 273,508,970 and 364,678,620 horses, working incessantly during the whole period of the year.

10. *Auroral Belt of April 7*, 1847.—Observations made at Hartford, Conn., by P. W. Ellsworth, M.D., combined with those made at New Haven, show that the auroral bow or arch of April 7, 1847, was elevated not less than 100 miles, nor more than 120, above the earth's surface. The observations will be published in the next number.

A similar auroral bow or arch was seen at various places in England, on the 19th March, 1847. According to the mean of various observations, its elevation was about 177 miles. A brilliant display of the Aurora Borealis was seen at New Haven, on that evening, but no such arch was visible here up to $11^{h.}\ 30^{m.}$ P. M. E. C. H.

11. *Volcanic Eruption at the Cape Verds.*—There was a volcanic eruption about the 1st of April, on the island of Fogo, (of the Cape Verd group,) which continued ten or fifteen days, throwing out showers of earth and stones to a great height, and emitting huge streams of lava, which, running down the mountain, destroyed many houses and plantations, and caused some loss of life. All vegetation and many goats and cattle were destroyed by the heat of the earth, the showers of stones and the lava. The shock was distinctly felt on the neighboring islands, and caused much alarm at Port Praya, where the vibrations were very violent and almost unceasing for seven or eight days. The crater of Fogo is 12,000 feet above the sea, and eruptions occur once in twenty or thirty years.—*Salem Reg.*

12. *Science and the Arts at Harvard.*—The Hon. Abbott Lawrence of Boston, has presented to the Corporation of Harvard University, the sum of fifty thousand dollars, to be expended in establishing a school for the purpose of teaching the practical sciences, embracing Engineering, Mining in its extended sense, including Metallurgy, and the invention and manufacture of Machinery. One department is already occupied by the Rumford Professor in that institution, Prof. E. N. Horsford.

13. *Association of American Geologists and Naturalists.*—The eighth annual meeting of the Association of American Geologists and Naturalists, will be held in Boston, commencing on the third Monday (20th) of September, 1847, at 10, A. M., continuing for one week thereafter.

Officers of the Association elected at the last meeting:

Chairman, Dr. Amos Binney.*
Treasurer, Prof. B. Silliman, Jr.
Secretary, Dr. J. Wyman.

Standing Committee.—The President, Treasurer, and Secretary, *ex officio*. Dr. J. E. Holbrook. Prof. H. D. Rogers. Prof. B. Silliman. Pres. E. Hitchcock. William C. Redfield, Esq. Lardner Vanuxem, Esq. L. C. Beck. John L. Hayes.

Local Committee.

Hon. Nathan Appleton.
Hon. Abbott Lawrence.
John A. Lowell, Esq.
Dr. John C. Warren.
Prof. A. Gray.
Dr. A. A. Gould.
Dr. D. H. Storer.
Dr. S. Cabot, Jr.
Dr. C. T. Jackson.
Francis Alger, Esq.

VI. Bibliography.

1. *Elementary Geology;* by Edward Hitchcock, D.D., LL.D., President of Amherst College; eighth edition, revised, enlarged and adapted to the present advanced state of the science, with an introductory notice by John Pye Smith, D.D., F.R.S., and F.G.S., &c. New York, 1847.—This work has long sustained its well deserved reputation.

* Since deceased.

It is in some respects peculiar; its structure is highly methodical; the subjects are presented in distinct propositions, with definitions, principles, proofs, remarks, inferences, descriptions, illustrations, causes, &c., all drawn out under distinct heads, and distinguished by larger and smaller type. If this construction presents a page more broken up than is agreeable to the eye, and less readable as a straight forward treatise, it presents important advantages, as a book for classical study and recitation. The pupil will know what to study and how to study, and the instructor what to enquire for. The unsolicited expressions of approbation from many geologists and reviews which are prefixed to the work, especially the beautiful notice of the distinguished Dr. John Pye Smith, of London, himself the author of an important work on the relation of geology to the Mosaic cosmogony, are to be regarded as decisive proofs of the approbation of those who are the best qualified to judge. The work bears throughout, the impress of a working, thinking man, of strong powers of observation and reasoning; of one whose impressions are obtained from nature quite as much as from books; whose facts are correct, whose views are sound and tenable, and who is therefore a safe guide.

2. *Dr. Mantell's Geology of the Isle of Wight.*—At the moment of closing the present number, we have received a copy of this new and beautiful work of Dr. Mantell, of which a fuller notice will be given hereafter.

3. *Medical Botany, or descriptions of the more important Plants used in Medicine, with their history, properties, and mode of administration;* by R. Eglesfeld Griffith, M.D. Philadelphia: Lea and Blanchard. 1847; pp. 704, 8vo. Illustrated by 338 wood-cuts.—The author of this volume is well known to be particularly qualified for this undertaking, by his botanical, as well as medical and pharmaceutical knowledge; and it strikes us, on a cursory examination, that it has been prepared with much care and faithfulness, and that it will take its place at once as the standard work on the subject in this country. A succinct introductory chapter is devoted to the anatomy and structure of plants, their chemical composition and products, and the outlines of classification. The officinal plants are introduced under their several natural orders, which, with the general systematic arrangement of De Candolle, are thrown into groups after the manner of Lindley. The class of *Sporogens* is retained, as is still done by the last named author, although it has been abundantly shown that its assumed character is without foundation in nature. The plants which are really important in the materia medica are described in full, as well as the officinal part or production; the others are more briefly noticed; and the references which are faithfully made, both to the botanical and medical authorities, will serve in all cases to direct the inquirer to the original sources of information. A. Gr.

4. *Principles of Geology—or, the Modern Changes of the Earth and its Inhabitants, considered as illustrative of Geology;* by Charles Lyell. Seventh edition, entirely revised, with plates, maps and wood-cuts. London: John Murray. 1847.—This work, heretofore published in three and four duodecimo volumes, now appears in one thick 8vo of 810 pages, agreeably to a modern usage in scientific works of frequent reference.

It is unnecessary to say any thing of the excellence of a work, whose reputation has been long established and which no one can read without both pleasure and instruction. One of the most striking peculiarities in this edition is seen in the more frequent reference to American facts with which the author's two visits to this country and extensive travels in it have made him acquainted.

5. *A Dictionary of Modern Gardening;* by GEO. WM. JOHNSON. London. Edited by WM. LANDRETH of Philadelphia. Lea & Blanchard. 1847. 1 vol. 12mo. pp. 635.—This is a useful compendium of all that description of information which is valuable to the modern gardener. It quotes largely from the best standard authors, journals, and transactions of societies; and the labors of the American editor have fitted it for the United States, by judicious additions and omissions. The volume is abundantly illustrated with figures in the text. The articles, 'apple,' 'pear,' 'cherry,' 'plum,' 'peach,' embrace a brief and judicious selection of those varieties of fruits which experience has shown to be well suited to the United States.

6. *A Manual of Road Making, comprising the location, construction, and improvement of Roads (common, Macadam, paved, plank, etc.) and Railroads;* by WM. GILLESPIE, A.M., C.E., Professor of Civil Engineering in Union College. New York: A. S. Barnes & Co. 1 vol. 12mo. pp. 336. 1847.—If the well established principles of road building, which are so plainly set forth in Prof. Gillespie's valuable work, and so well illustrated, could be once put into general use in this country, every traveller would bear testimony to the fact, that the author is a public benefactor.

7. *Transactions of the American Philosophical Society, Philadelphia,* Vol. ix, New Series, part iii.—p. 275. Description of New Fresh Water and Land Shells, with figures; by *I. Lea.*—p. 283. Observations made in the years 1838–1843, to determine the magnetic dip and intensity in the United States; by *John Locke,* M.D., Prof. Chem. and Pharm. in the Med. College of Ohio.—p. 329. Observations of the magnetic dip made at several positions, chiefly on the southwestern and northeastern frontiers of the United States, and the magnetic declination at two positions on the river Sabine, in 1840; by Maj. *J. D. Graham,* U. S. Corps of Topographical Engineers.

The following officers of this Society were elected on January last.

President—Nathaniel Chapman, M.D.

Vice-Presidents—R. M. Patterson, M.D., Franklin Bache, M.D., A. Dallas Bache, LL.D.

Secretaries—Hon. J. K. Kane, Robley Dunglison, M.D., A. L. Elwyn, M.D., J. F. Frazer.

Counsellors for Three Years—Robert Hare, M.D., Wm. Hembel, C. D. Meigs, M.D., Henry Vethake.

Curators—E. Peale, J. P. Wetherill, John C. Cresson.

Treasurer—George Ord.

PROCEEDINGS OF THE AMERICAN PHILOSOPHICAL SOCIETY.—Vol. iv, No. 36, *July—December,* 1846.—p. 279, Letter from Dr. *Franklin* to Dr. Kimmersly, on "the effect of lightning on Mr. Holder's House."—p. 285, Observation by *Prof. Henry* on the interference of rays of heat, including his result that two rays may be thrown on each other so as to produce a reduction of temperature.—p. 287, Remarks on the Corpuscular theory; *Prof. Henry.*

No. 37. *Jan., Feb. and March*, 1847.—p. 299, List of officers for the year.—p. 305, On the Corpus luteum; *Dr. Meigs.*—p. 311, A missing star in Lalande's Chart, shown probably to be LeVerrier's planet, and determining the position of this planet in 1795; *S. C. Walker.*

Proceedings of the Academy of Natural Sciences of Philadelphia.—Vol. iii, No. 7, *Jan. and Feb.*, 1847.—p. 143, Observation on fossil trees in the Nova Scotia coal mines, by *R. Brown*, Esq.; in which he remarks of one tree, "it has exposed two long roots, one branching to the north and the other to the south, about seven feet each way. They are very broad and flat, and are genuine *Stigmaria*. I could not trace any rootlets, but the areolæ are not to be mistaken. I have preserved some large pieces, as also some of the bark of the tree, which is apparently an irregularly fluted *Sigillaria*."—p. 149, Description of new Insects; *S. S. Haldeman:* Blethisa quadricollis, Chorea (*n.* gen.) pulsator, Eburia distincta, Enapholodes simplicicollis, Stenura? cyanea, Ploiaria maculata.—On the Cranium of the Zeuglodon from the Upper Eocene of South Carolina; *M. Tuomey.* "Length 14½ inches; greatest breadth 7½ in.; height 5½. It was evidently a young individual. The double occipital condyle shows it to have been a mammal, while the squamous sutures and a symmetrical form refer it to the Cetacea."—p. 154, Remarks on the birds observed in Upper California; *Wm. Gambel:* includes the new genus Chamæa, instituted for Parus fasciatus, (Proc Acad. Nat. Sci., ii, 265,) and various valuable observations on known species.—New Coleoptera of the United States; *F. E. Melsheimer:* includes species of the genera Donacia, Orsodacna, Microrhopala, Galeruca, Calomicrus, Œdionychis, Pachyonychus, Disonycha, Graptodera, Systena, Crepidodera, Psylliodes, Aphthona, Thyamis, Dibolia, Chætocnema, Sphæroderma, Metachroma, Eumolpus, Cryptocephalus, Monachus, Gastrophysa, Phædon, Tritoma, Triplax, Lycoperdina, Coccinella, Brachiacantha, Hyperaspis, Exochomus, Chilocorus, Scymnus. This closes the descriptions of Dr. Melsheimer, which were begun in Vol. ii, No. 2, (April, 1844,) of the Proceedings.

No. 8, *March and April.*—p. 185, On living hybrids in Pennsylvania between the Guinea fowl and the Turkey; *A. Sharpless* and *W. Kite.*—p. 190, Larva of the Cicada septendecim; *Miss Morris.*—p. 191, Composition of the dust of anthracite furnace flues; *Prof. Johnson.*—p. 199, Cyminidis Wilsonii, a new rapacious bird from Cuba; *J. Cassin.*—p. 200, Remarks on the birds observed in Upper California; *Wm. Gambel.*

Proceedings of the Boston Society of Natural History, February, 1847.—p. 193, Blind Crawfish of the Mammoth Cave, (Astacus pellucidus;) *W. F. Channing.*—Prof. Agassiz mentioned the fact ascertained by Erichson, that the Crawfishes of America have all one pair of gills less than those of the old world.—p. 195, Microscopic examination of Gun-cotton; *Dr. Bacon.*—p. 196 and 200, Description of New Shells of the Exploring Expedition, (three species of Partula, two of Pupa, one of Balea, five of Achatinella, seven of Helicina, nine of Cyclostoma, and four of Truncatella; *A. A. Gould.*—p. 198, A new species of Manatus, from Cape Palmas, (M. nasutus;) *G. A. Perkins.*

Ann. and Mag. Nat. Hist., Vol. xix, No. 126, April, 1847.—On Genus of Insects, Trachyphlæus; *J. Walton.*—A new species of Dawsonia; *R. K. Greville.*—On some Chalcidites and Cynipites in the collection of Rev. F. W. Hope; *F. Walker.*—Birds of Calcutta; *C. J. Sundevall.*—Development of the Lycopodiaceæ; *K. Müller.*—On the Siliceous Bodies of the Chalk and other formations; *J. S. Bowerbank.*—A new species of Penella.—Development of Echinidæ; *M. Dufossé.*—Zoological Society.—*L. Pfeiffer* on new land shells; *L. Reeve* on new species of Chama; *J. H. Jonas* on two new shells.—Bot. Soc. of Edinb.—*Rev. Dr. Fleming* on the defoliation of trees; *Dr. Balfour* on Carex saxatilis and C. Grahami.

Annales des Sciences Naturelles.—*September.*—Forms of the Crania of the inhabitants of the North; *Retzius, Creplin.*—On the Nemertidæ; *de Quatrefages.*—On the Arceuthobium Oxycedri; *A. R. de Fonvert.*—On grafting of Gramineæ; *J. Calderini.*—Conspectus of the genus Biebersteinia; *Joubert* and *Spach.*—On varieties, subspecies and species; *Chevreul.*

October.—On the Nemertidæ; *de Quatrefages.*—On species, &c.; *Chevreul.*—Development of leaves; *C. E. de Mercklin.*—On the genus Godoya and its analogues; *E. Planchon.*

November.—On the Nemertidæ; *de Quatrefages.*—Pulmograde Medusæ of the British Seas; *E. Forbes.*—Genera and species of Echinodermata; *Agassiz* and *Desor.*—Genus Godoya and its analogues; *E. Planchon.*—On the Development of the

embryo and anomalous corolla in the Ranunculaceæ and Violariæ; *F. M. Barneoud*: ibid, *A. Brongniart*.—On the origin of roots; *A. Trécul*.

December.—Agassiz's Echinodermata continued.—Metamorphosis of the Scathopses nigra; *Dufour*.—Origin of roots; *A. Trécul*.—Analecta Boliviana; *J. Remy*.—Note on the Zamia muricata; *de Vriese*.—Flora of Colombia; *L. R. Tulasne*.—On the duration of the faculty of germinating in grains of different families.

January. 1847.—Metamorphosis of the Subula citripes and Cassida maculata; *Dufour*.—On the petrifaction of shells in the Mediterranean; *M. de Serres* and *L. Figuier*.—Development of the Echini; *Dufossé*.—Lobiger and Lophocercus, new genera of Gasteropoda; *Krohn*.—On the circulation of the blood in the Coleoptera; *Nicolet*.—Development of the ovule in the Avicennia; *W. Griffith*.—On the Ustilagineæ, compared with the Uredineæ; *L. R. and C. Tulasne*.

Comptes Rendus Acad. Sci. Paris.—*Dec.* 28, 1846.—On the Trilobites of the schist of Brittany; *M. Rouault*.—On the elasticity and cohesion of the principal tissues of the human body; *G. Wertheim*.—*Jan.* 4, 1847.—On pyroxyline; *Pelouze*.—Microscopic anatomical researches on the shell of Decapod Crustacea; *J. Lavalle*.—*Jan.* 11.—On the relation between charges of powder and the initial force they communicate to balls, &c.; *Morin*.—Provisional elements of Leverrier's planet; *Valz*.—*Jan.* 18.—Essay on tidal currents and liquid waves; *Keller*.—*Jan.* 25.—On pyroxyline, hypoazotic cotton and xyloidine; *Payen*.—Compounds with Mannite, &c. analogous to pyroxyline; *Flores Domonte* and *Menard*.—Effects of ether in respiration; *Roux, Velpeau, Langier, Gerdy*.—On the borates; *A. Laurent*.—*Feb.* 1.—Effects of ether; *Velpeau, Magendie, Milne Edwards, Roux, Lallemand*.—New system of aerial locomotion; *van Hencke*.—*Feb.* 8.—Effects of ether on animals; *Gruby*.—New series of acids of sulphur; *Plessy*.—Inhalation of ether; *Bouvier, Hutin, Tavernier*.—*Feb.* 15.—Memoir on a new mode of treating nitrates, and especially saltpetre; *Pelouze*.—Action of chlorated alkalies on polarized light and on the animal economy; *A. Laurent*.—Effects of ether; *Serres, Magendie, Velpeau, Roux, Flourens*.—M. Civiale elected a member in place of M. Bory de Saint Vincent, deceased.—On detonating products from nitric acid and sugar, dextrine, &c.; *A. Sobrero*.—*Feb.* 22.—Effects of inhalation of ether on the medulla oblongata; *Flourens, Magendie*.—Connection between the difference in constitution of sulphuric and nitric ethers, and their different effects on the animal economy; *Balard*.—Equilibrium of bodies; *de Saint-Venant*.—Influence of alkalies in different natural phenomena, and especially of ammonia in nutrition; *F. Kuhlmann*.—Inhalation of ether; *Laugier, Gerdy, Amussat, Landouzy*.—On the compounds of phosphorus; *Wurtz*.—Formation of the Aorta.—Elements of Hind's comet of Feb. 6.—*March* 1.—On the decease of B. Delessert.—On the Artesian well near Calais.—On the movements of a system of molecules; *Cauchy*:—on some properties of complex factors; *Cauchy*.—*March* 8.—On the Hipparitherium, new genus of Solipeds; *Christol*.—Researches on electric conductility; *Becquerel*.—On the use of ether for distinguishing pretended disorders from real; *Baudens*.—Effects of ether; *Flourens, Joly, Amussat, Cardan, Bourguet, Mayor*.—Pyroxyline; *Richier*.—*March* 15.—On the mineral water of the Paramo de Ruiz, N. Granada; *Boussingault, Levy*.—Compositions of different kinds of wood; *Chevandier*.—On the true nature of anhydrous fluohydric acid; *Louyet*.—Compounds of cyanogen; *Wurtz*.—On terrestrial magnetism, or a new principle of celestial physics; *Lion*.—Glaciers of the north and center of Europe; *Durocher*.—Hind's comet.—*March* 22.—Polynomial radicals; *Cauchy*.—Ether injected into the veins; *Flourens*.—Effects of ether.—Hind's comet.—*March* 29.—Simple electro-chemical currents formed of liquids; *Becquerel*.—Polynomial radicals; *Cauchy*.—Identity of Leverrier's planet with a star observed by Lalande.—Theory of dew; *Melloni*.—On the potato disease; *Payen*.—Mechanical properties of different kinds of wood; *Chevandier and Wertheim*.—Method of determining the nitrogen in organic substances; *Peligot*.—Apparatus for determining the velocity of electricity; *Silbermann*.

Archiv für Naturgeschichte, *Berlin, 4th Heft*, 1846.—On a new species of Proteus; *H. Freyer*.—On the contractile cells of the embryo of Planaria; *A. Kölliker*.—Gammarus ambulans, n. sp.; *A. F. Müller*.—Acanthocerus rigidus, n. sp. of Crustacea, Fam. Cladocera; *J. E. Shödler*.—Notice of works and memoirs on mammalia and birds, for the year 1845; *A. Wagner*.

APPENDIX.

Descriptions of Fossil Shells of the Collections of the Exploring Expedition under the command of CHARLES WILKES, U.S.N., *obtained in Australia, from the lower layers of the coal formation in Illawarra, and from a deposit probably of nearly the same age at Harper's Hill, valley of the Hunter;* by JAMES D. DANA, Geologist of the Expedition.*

1. *Bellerophon undulatus.*—Sparingly compressed, back of whorls rounded, surface smooth, having a series of distant plications crossing the back parallel with the lines of growth, (or nearly V shape with the angle rounded,) giving it an undulate outline, plicæ most abrupt on posterior side, becoming obsolete laterally, aperture deltoido-lunate, a little dilated laterally.—Diameter of species ¾ inch; thickness through the centre ⅜ of an inch; about four plications in a distance of half an inch. —*Harper's Hill.*

2. *Bellerophon strictus.*—Discoid, much compressed, smooth and without markings, aperture narrow compressed-lunate, not dilated, the part of the aperture either side of the included body of the shell very narrow; back of the whorls rotund. Thickness at middle half the diameter. Resembles a Goniatite, but there are no septa.—*Illawarra.*

3. *Platyschisma? depressum.*—Large, very much depressed, suborbicular, spire very low; whorls three or four, much flattened, back somewhat truncate, surface without markings excepting striæ of growth. —Diameter 4½ inches.—*Harper's Hill.*

4. *Pleurotomaria tri-filata.*—Shell rather short turreted; whorls four, separated by a distinct suture, back tri-carinate, the middle carina largest, subacute; aperture orbicular.—Large specimens are eight lines long, and five broad at base.—*Harper's Hill* and *Illawarra.*

5. *Pleurotomaria nuda.*—Shell much depressed, whorls four or five, smooth, rounded, low-carinate, with an obsolete sulcus either side of carina; volutions separated by a distinct suture.—Specimen is ¾ of an inch in diameter, and about half an inch in length.—*Harper's Hill.*

6. *Natica* ——*?*—*Illawarra.*

7. *Patella tenella.*—Short conical, apex pointed, slightly recurved, not projecting beyond base; base oblong ovate, narrowest beneath the beak, length about twice greatest breadth. Length of base ⅝ of an inch; height ⅜ of an inch. On the specimen, which is a neatly pre-

* A detailed account of these and other fossils from Australia, illustrated by figures, will appear in the Government Geological Report by the writer, now nearly ready for publication. As interesting associations of species and genera will be perceived, the writer would remark, that the species with few exceptions were obtained by himself at the localities. He offers here no opinion as to the particular age of the deposits.

The writer would acknowledge the very essential aid he has kindly received from Prof. Agassiz in the study of many of the species.

served cast, only a small portion of the original shell remains, from which it appears that the surface was smooth, and marked only by faint lines of growth.—*Harper's Hill.*

Pentadia, (nov. gen.)—This name is proposed for singular flat fossils, which have one side quite smooth, the other delicately and closely marked with parallel subcrenulate ridges having the angles of a regular pentagon and concentric. Two of the specimens are casts of the exterior, and the other is a calcareous petrifaction. As the last mentioned is quite solid, having the oblique cleavage of many calcareous fossils, (the spines of Echini, &c.) it is evident that the original was solid, and could not have been a *Porpita*, which one of the specimens somewhat resembles. And since, besides, there is no appearance of a mouth or any opening, or organs of motion, and the form varies very much, we may infer that the fossils were an internal secretion probably of some mollusk, and more allied to the cuttle-fish bone than any thing else we can suggest. The first species here described has much the appearance of a Spatangus.

8. *Pentadia spatangus.*—Form pentagonal or approximately twelve-sided, suborbicular, with five broad and rounded folds (one largest) radiating from the centre. The concentric pentagonal markings have the five angles at the centres of the triangular sections; and at the centres of four of the sides of the pentagon, there is a reëntering angle.—Diameter 2 inches; thickness $\frac{1}{8}$ inch.—*Illawarra.*

9. *Pentadia reniformis.*—Resembles a single segment of the preceding, with a broad lateral wing-like prolongation, nearly as large as the segment. It is quite thin, and its shape is reniform, though somewhat arcuately flexed. The specimen is undoubtedly a perfect individual.—Length $\frac{3}{4}$ inch; breadth $1\frac{1}{4}$ inch; thickness 1 line.—*Illawarra.*

10. *Pentadia trigona.*—Shape triangular, slightly arcuately flexed. It is thicker than either of the preceding, and has a rounded margin. It resembles the last in its markings, having the same angle of intersection (that of a pentagon) between two sets of parallel lines.—Breadth 1 inch; thickness $\frac{1}{4}$ inch.—*Illawarra.*

11. *Lingula ovata.*—Quite small, regularly broad ovate, acute at beak, margin not at all truncate; valves thin, very convex; surface smooth with faint concentric lines of growth.—Dimensions, from the beak to the opposite margin $\frac{1}{4}$ of an inch; transverse line a fourth less.—Very near the *L. lata* of Murchison, (Sil. Syst., pl. 8, fig. 11,) but not at all "squarish."—*Illawarra.*

12. *Terebratula amygdala.*—Oblong ovate, attenuate above, thickest about the centre, valves about equally and regularly convex, inferior margin arcuate, ventral valve very regularly ovate in outline; beak reflexed close to apex of ventral valve; aperture round and rather large; line of junction of valves in side view almost straight, very slightly bent above, the cardinal edges being little concave; surface smooth with a few concentric folds and some faint radiations.—Cardinal angle 82°; height $1\frac{1}{8}$ inch; breadth $\frac{72}{100}$ H.; thickness $\frac{48}{100}$ H. Near the *T. hastata.*—*Illawarra.*

13. *Terebratula elongata.*—(*Verneuil*, Palæozoic Rocks of Russia, p. 63, pl. ix, fig. 9.)—Scarcely differs from this species as described and figured by Verneuil.—*Illawarra.*

14. *Productus fragilis.*—Subquadrate, with front angles rounded, rather broader than long, hinge line straight, nearly of the breadth of the shell, front straight, upper valve very convex, irregularly longitudinally striated, with some concentric plications, sometimes with occasional rudiments of spines, front and sides rather abruptly reflexed; beak small, projecting but little below the hinge line, and the apex not much inflexed.—Length of hinge line $1\frac{1}{2}$ inches; depth of concavity below, over half an inch.—This species is very unlike the *brachythærus* in its less prominent beak and longer hinge line. It is near the *rugosus*, but is much thicker and more convex above.—*Illawarra.*

15. *Solen* (*Solecurtus?*) *ellipticus.*—Shell very slightly convex, very regularly elliptical, with no trace of a beak, breadth little less than half the length, anterior part rather more than one-third the whole length; smooth with fine scarcely apparent concentric striæ, superoanterior margin slightly depressed, and perhaps two or three faint radiations from the hinge over the lateral surface (apparent in the cast of the under surface of the valve, but not of the upper); cast of the hinge showing no teeth though apparently perfect.—Length 1·4 inches; height $\frac{48}{100}$ L.—*Illawarra.*

16. *Solen* (*Solecurtus?*) *planulatus.*—Shell flat except a slight bending over the postero-dorsal portion; no beak, elliptical in outline with the inferior and dorsal margins straight, and the anterior and posterior extremities of equal breadth; breadth more than half the length; surface smooth with some faint concentric undulations and lines of growth, apparent especially near inferior margin; no palleal or muscular impressions visible.—Length $1\frac{2}{3}$ inch; height $\frac{48}{100}$ L.—*Harper's Hill.*

17. *Pholadomya undata.*—Nearly or quite equivalve, oblong transverse, subelliptical; beak projecting but little; thinning to an acute edge in front, prolonged and narrowing somewhat behind; sides flattened, posterior surface from the beak to the posterior angle obliquely truncate and exteriorly subcarinate; cardinal area linear, circumscribed; surface with a few irregular obsolescent longitudinal plicæ or undulations, smooth, crossed, especially below, by faint radiations.—Length $3\frac{1}{16}$ inches; height $\frac{59}{100}$ L; thickness $\frac{35}{100}$ L; distance of summit of beak from anterior margin $\frac{33}{100}$ L; apical angle 138°; projection of beak above cardinal margin one-eighth of an inch.—*Illawarra.*

18. *Allorisma audax.*—Transverse, very inequilateral, left valve largest, front very broad and flattened, and having a narrow area adjoining the margin extending down from the beaks which is a little concave; posterior prolonged and much compressed, narrowing and somewhat recurved, gaping; beaks very large and prominent, incurved, contiguous; lateral surface anterior to middle strongly flattened, or even concave; surface unevenly plicate and having some faint radiations laterally and posteriorly, plications large rounded and smooth, the alternate mostly becoming obsolete towards middle of lateral surface.

Length $4\frac{3}{4}$ inches; height $\frac{63}{100}$ L; thickness $\frac{47}{100}$ L; the beaks are much more prominent than in the *A. curvatum*, the posterior extremity much narrower, the flank less inflated, and the front more abruptly truncate.—*Illawarra.*

Cleobis, (nov. gen.)—Shell inequivalve, inequilateral, thick, transverse subovate, closed (or nearly so.) Beaks large, salient and incurved. Posterior margin broadly rounded and a little dilated. Ligament internal. Hinge line flexed to one side at middle and passing beneath the lower of the beaks. Valves thin. Surface marked unevenly with regular concentric striæ of growth and without radiations.—This genus appears to be near the Ceromya of Agassiz; but of this we cannot be certain, as the palleal and muscular impressions are not visible. There is much external resemblance to the *Avicula cuneiformis* of Verneuil, (Russia, pl. xli.) The beaks are prominent and incurved, but are not flexed at all forward; they project over or overhang the cardinal line, the summit being separated from it by an intervening space. The valves are quite thin, the thickness being less than a line in a large species measuring seven inches in length.

19. *Cleobis grandis.*—Thick, very convex, right valve largest; front very abrupt; anterior part about one-third the whole length; inferior margin regularly arcuate; surface concentrically striate and a little undulate.—Length of large specimens seven inches, height $\frac{69}{100}$ L; thickness $\frac{60}{100}$ L; apical angle 105° —*Illawarra.*

20. *Cleobis gracilis.*—Resembling *C. grandis*, but more projecting anteriorly; anterior portion, about two-fifths the whole length.—Length 2·9 inches; height $\frac{72}{100}$ L; thickness $\frac{50}{100}$ L; apical angle 125°.—*Illawarra.*

21. *Cleobis? recta.*—Subelliptical, somewhat compressed; lateral surface flattened; marked with concentric lines of growth; inferior margin straight at middle, parallel with dorsal; postero-dorsal margin much dilated.—Length 3½ inches; height probably $\frac{69}{100}$ L; thickness $\frac{41}{100}$ L. The straight lines of growth over the medio-lateral surface, and straight medio-inferior margin give a peculiar character to this species.—*Illawarra.*

22. *Astarte gemma.*—Transverse, very nearly equilateral, surface evenly convex, delicately marked with deep concentric striæ, margin of the valves crenulate within; large anterior muscular impression a little excavate, transverse and suboval; smaller anterior excavate, oblong; posterior rather faint; palleal impression faint but distinctly without a sinus, and quite reaching the anterior muscular impression; surface of cast smooth.—Length $\frac{3}{5}$ inch; height $\frac{83}{100}$ L; thickness $\frac{45}{100}$ L; anterior part $\frac{7}{15}$ of the whole length; apical angle 140°. The impression of two divergent teeth is finely preserved.—*Illawarra.*

The following species have the entire palleal impression, two anterior and one posterior muscular impressions, and the external ligament of *Astarte*. Yet the form is more transverse and inequilateral than is characteristic of that genus, and the ligament is longer, occupying the whole cardinal area. The beak of an interior cast has the summit obliquely truncate, and the lateral surface just posterior to middle is more or less flattened. The large muscular impressions are broad subelliptical or suborbicular, with the upper side often straight. The smaller anterior is situated under the beaks as in Astarte. The exterior surface is concentrically striate. The valves at middle are quite thin, hardly $\frac{1}{60}$ of an inch in the first of the following species, and they thicken below towards the margin, where the same species is

half a line thick. Although we have not yet made out the teeth of the hinge, we propose to describe the species under the generic name *Astartila*.

23. *Astartila intrepida.*—Thick, somewhat transverse, neatly but somewhat unevenly concentric striate; anterior part about $\frac{1}{3}$ the whole length. Anterior muscular impression excavate; smaller subquadrate or a little oblong; larger marked with a number of fine vertical striæ on the lower posterior quarter; antero-lateral surface of the interior with two parallel flattened areas, the one adjoining the muscular impression convex, (concave in the cast.)—Length $1\frac{3}{4}$ inch; height $\frac{89}{100}$ L; thickness $\frac{52}{100}$ L; apical angle about 120°.—*Illawarra.*

24. *Astartila cyprina.*—Thick, transverse, length more than one third greater than height; palleal impression very distinct, inner surface of valve very minutely rugose, below palleal impression radiately subplicate; posterior muscular impression not excavate, crossed vertically by a fold; large anterior deeply excavate, convex, crossed by a few faint vertical lines, which are closer towards the posterior margin; smaller somewhat excavate, oblong sigmoid. Cast with antero-lateral surface simply a little flattened.—Length $2\frac{1}{12}$ inches; height $\frac{72}{100}$ L; thickness $\frac{58}{100}$ L; apical angle about 118°.—*Illawarra.*

25. *Astartila cytherea.*—Thick, slightly longer than the height; inner surface smooth, palleal impression rather faint; posterior muscular impression large and very distinct, very slightly excavated, not intersected by a vertical fold; larger of the two anterior deeply excavate, the excavation deep and very abrupt on the upper side, four or five striæ crossing the muscular impression vertically near posterior margin; smaller anterior oblong sigmoid, but not excavate. Cast with antero-lateral surface simply somewhat flattened.—Length of *cast* $1\frac{1}{2}$ inch; height $\frac{90}{100}$ L; thickness $\frac{66}{100}$ L; apical angle 112°.—*Illawarra.*

26. *Astartila polita.*—Rather thin, somewhat transverse; surface smooth and shining, with faint lines of growth; muscular impressions scarcely excavate and palleal impression faint; the larger anterior very even and without vertical striæ or plications; a slight fold in the surface just anterior to posterior muscular impression, and a smaller one crossing this muscular impression. Cast with antero-lateral surface simply very slightly flattened.—Length 1 to $1\frac{3}{4}$ inch; height $\frac{74}{100}$ L; thickness $\frac{50}{100}$ L; apical angle about 113°.—*Illawarra.*

27. *Astartila cyclas.*—Rather thin, slightly transverse; surface marked unevenly with concentric striæ; posterior muscular impression very distinct but hardly excavate, a fold in the inner surface of the valve just anterior to it; both of the anterior muscular impressions strongly excavate; the larger without vertical striæ; the smaller placed obliquely so that the cast of it is a linear trenchant ridge; palleal impression very distinct, somewhat plicatulate. Cast with summits of beaks quite thin, the lateral surface strongly flattened, and another flattened area adjoining anterior muscular impression.—Length $1\frac{1}{3}$ inch; height $\frac{90}{100}$ L; thickness $\frac{45}{100}$ L; thickness of cast $\frac{40}{100}$ L; apical angle 135°.—*Illawarra.*

28. *Astartila transversa.*—Thick, transverse, length full a third greater than height; posterior muscular impression faint; crossed by a fold vertically, and another more distinct in the surface just anterior to

the muscle; large anterior somewhat excavate, without vertical striæ, small anterior obliquely excavate; palleal impression not very distinct. Cast with antero-lateral surface of beak strongly flattened in two parallel planes, that adjoining the anterior muscular impression a little concave. —Length of cast 1½ inch; height $\frac{7}{10}\frac{3}{0}$ L; thickness $\frac{5}{10}\frac{5}{0}$ L; apical angle of cast 105°, of shell about 115°. This species has two parallel flattened areas on the lateral surface like the *intrepida* and *cyclas;* but its form, the absence of vertical striæ from the anterior muscular impression and other characters distinguish it.—*Illawarra.*

Genus CARDINIA, (*Ag.*)—Form of the species below-described, transverse, and dorsal margin more or less convex without a salient beak; two strong anterior muscular impressions, and one posterior less distinct, the smaller anterior linear, and situated vertically on the front; the palleal impression entire, and not quite reaching to the anterior muscular impression. No cardinal area to the shell, but a strongly defined one to the cast of the interior. The species differ from Cardinia in having the lateral surface posteriorly marked with radiations; the front of an interior cast is strongly truncate, and the flat truncate surface extends on and separates the anterior margins of the large anterior muscular impressions from the medial line; the cardinal areas in the cast are very long linear, and but slightly widen posteriorly. We refer the *Orthonota? costata*, of Morris, to this genus.

29. *Cardinia recta.*—Very inequilateral, narrowing much posteriorly, length 2½ times the breadth, dorsal margin a little convex, inferior straight at middle; lateral surface not depressed, marked with concentric striæ and faint radiations, these radiations producing slight undulations in the lines of growth; palleal and posterior muscular impressions very faint, both of the anterior strong, a convex linear area adjoining the larger extending upward. Interior cast having a very neat, narrow and quite flat cardinal area, with the dorsal margin prominent; lower edge of the cast very thin; surface quite smooth with faint radiations.—Length 2 inches; height $\frac{4}{10}\frac{5}{0}$ L; thickness $\frac{2}{10}\frac{0}{0}$ L; apical angle 125°. The cast resembles much Verneuil's *Solemya primæva*, pl. xix, fig. 5.—*Illawarra.*

30. *Cardinia cuneata.*—Very inequilateral, length about twice the breadth, diminishing posteriorly, and thinning below; superior margin arcuate, interior strongly concave just posterior to middle, and lateral surface depressed; palleal impression distinct; anterior and posterior muscular impressions excavate. Cast with cardinal areas concave and separated from lateral surface by a strong carina, very long, extending to posterior margin.—Length of cast 1¼ inch; height $\frac{5}{10}\frac{3}{0}$ L; thickness $\frac{3}{10}\frac{0}{0}$ L; apical angle of cast 110°.—*Illawarra.*

Genus PYRAMUS, (nov. gen.)—Equivalve, somewhat inequilateral, transverse, elliptical, with the front and posterior margins nearly alike, entirely closed; beak somewhat prominent. Ligament external. Palleal impression entire, distant from the margin. Three muscular impressions to each valve, two anterior and one posterior; the larger anterior, suborbicular, smaller anterior, facing the same way with the larger, and situated just above its upper angle; posterior faint. Surface marked with concentric lines of growth. Cast of summit of beak a slender point. Shape nearly of Donacilla and Sanguinolaria, but it differs in its entire palleal impression, and has also two anterior muscular im-

pressions which belong together, to each valve, as in *Corbis*. From the impression of the hinge of a left valve, there appear to be no prominent teeth; it has a very oblique shallow sulcus, directed posteriorly from the centre of the hinge, and a slight excavation anterior to the centre. The form is more transverse and the teeth less distinct than in *Corbis*. It has not the long lunate muscular impression of *Lucina*.

31. *Pyramus ellipticus*.—Oblong, length half greater than breadth, lower margin arcuate, sides evenly convex, surface strongly but unevenly marked with regular concentric striæ, posterior and large anterior muscular impressions rather indistinct, not excavate; palleal impression perceptible and posteriorly plicatulate. Cast of beak acute at apex.—Length $1\frac{3}{4}$ inch; height $\frac{7.9}{10.0}$ L; thickness $\frac{4.1}{10.0}$ L; apical angle 137°. Another specimen, probably same species, three inches long.—*Harper's Hill*.

32. *Pyramus myiformis*.—Oblong, length two-thirds greater than breadth; exterior smooth, with faint striæ of growth; lower margin nearly straight, lateral surface below somewhat flattened; muscular impressions distinct, posterior not excavate, large anterior a little so above, smaller anterior deeply excavate, and the surface of attachment facing the same way with the larger; palleal impression faint. Cast having the beak terminate in a minute cylinder, and having the lateral surface, from the summit obliquely downward and backward, depressed. —Length 2 inches; height $\frac{6.1}{10.0}$ L; thickness about $\frac{3.5}{10.0}$ L; apical angle 148° or 150°. The front and posterior margin are more broadly rounded than in the preceding, the lower margin straiter, the apical angle much larger.—*Illawarra*.

33. *Nucula abrupta*.—Thick, elongate, transverse, rather abruptly narrowing behind the summit, and diminishing posteriorly; posterior dorsal margin much concave; anterior margin rounded; cast strongly carinate from the beak to the posterior angle, and having a wide and flat cardinal area; palleal impression distinct, somewhat excavate, smooth; anterior muscular impression somewhat excavate, smooth; posterior strongly excavate in the upper part, (in the cast it lies around the posterior carina, and the upper extremity forms an abrupt angle on the outline of the carina;) surface of cast smooth, some faint radiations hardly distinguishable.—Length $1\frac{1}{3}$ inch; height $\frac{7.7}{10.0}$ L; thickness $\frac{4.9}{10.0}$ or $\frac{4.5}{10.0}$ L; apical angle about 135°; height in the line of the upper part of posterior muscle, about half greatest height.—*Illawarra*.

34. *Nucula* ——? *Harper's Hill*.

35. *Cypricardia rugulosa*.—Oblong transverse, anterior part one-third whole length, narrowing rather abruptly from the beak posteriorly, posterior surface (flank) broad and flat truncate, with a carinate margin extending from the beak to the lower posterior angle; cardinal area distinct, profound; lateral surface marked with longitudinal striæ of growth, which are quite irregular or undulate, making a right angle (and in some parts a less angle) at the carina; also a few large obsolescent longitudinal folds.—Length 2·9 inches; height $\frac{5.5}{10.0}$ L; thickness $\frac{3.3}{10.0}$ L; apical angle 132°.—*Illawarra*.

36. *Cypricardia sinuosa*.—Oblong transverse, anterior part about $\frac{2}{5}$ whole length; posterior rather rapidly narrowing but not abruptly;

flank nearly flat and rounding broadly into the lateral surface; lateral surface with a depressed area, extending from the beak to middle of inferior margin; inferior margin straight at middle; surface marked unevenly with fine striæ of growth which are regularly concentric.—Length $3\frac{2}{3}$ inches; height $\frac{58}{100}$ L; thickness $\frac{35}{100}$ L; apical angle about 142°.—*Illawarra.*

Myonia, (nov. gen.)—Shell thick, oblong transverse, inequivalve, very inequilateral, much gaping behind. Palleal impression strong, entire. Muscular impressions three to each valve; two anterior and one posterior, all excavate, smaller anterior on the front, posterior on the rounded carina between the flank and lateral surface. Valves thick. Lateral surface strongly flattened at middle or even concave.—Resembles much Panopæa and Pholadomya, especially Agassiz's Arcomya; but differs in its *entire* palleal impression, its second anterior muscle, as well as other characters.

37. *Myonia elongata.*—Thick, right valve rather the larger; greatest height half the length; gradually narrowing behind the beak, inferior margin just posterior to middle somewhat concave, carina from beak to posterior angle broadly rounded, not bent, flank flat, cardinal area long and circumscribed; surface strongly marked unevenly with regular concentric striæ of growth.—Length $6\frac{1}{5}$ inches; height $\frac{53}{100}$ L; thickness $\frac{42}{100}$ L; anterior part about half the posterior; apical angle 145°. —*Illawarra.*

38. *Myonia valida.*—General form of the *M. elongata*:—but greatest height much less than half the length; flank in cast flattened and distinctly bent near the posterior muscular impression; muscular impressions deeply excavate, and marked with deep vertical sulcations; palleal impression very strong with slender vermiform erosions extending upward from it; also scattered muscular impressions over lateral surface. —Of the same length with the preceding; but greatest height $\frac{58}{100}$ L; apical angle of cast 128°.—*Illawarra.*

39. *Eurydesma elliptica.*—Somewhat compressed, and dilated anteriorly and posteriorly, transverse, right valve largest; beaks contiguous; lateral surface not flattened; surface nearly smooth with occasional faint lines of growth and no trace of radiations; inferior margin arcuate.—Length $2\frac{3}{4}$ inches; height $\frac{89}{100}$ L; thickness $\frac{55}{100}$ L; apical angle 124°.—*Harper's Hill.*

40. *Eurydesma globosa.*—Thick, tumid, suborbicular, not transverse, very evenly convex; beaks contiguous; lateral surface every where convex; surface smooth with faint concentric lines of growth and no trace of radiations; inferior margin and lines of growth, regularly orbiculate.—Length and breadth $1\frac{9}{10}$ inch; thickness $\frac{79}{100}$ L; apical angle 97°.—*Harper's Hill? Illawarra.*

41. *Modiolopsis simplex.*—Elongate, length rather more than twice the height, very inequilateral, enlarging a little posteriorly; dorsal line horizontal, straight, and rounding into the posterior margin; obliquely truncate in front; inferior margin arcuate; lateral surface evenly convex without a depression anteriorly, or a carina posteriorly; surface marked rather faintly with lines of growth, a little uneven. —Length $1\frac{1}{2}$ inch; height $\frac{44}{100}$ L; apical angle about 132°.—*Illawarra.*

42. *Modiolopsis siliqua.*—Elongate, length nearly twice the height, very inequilateral, enlarging a little posteriorly; front obliquely truncate; anterior part less than a fourth whole length; dorsal margin straight and nearly horizontal, inferior margin straight; lateral surface flattened but not concave; posterior surface rounded or scarcely carinate near summit of beak; surface marked with irregular obsolescent plicæ and showing also lines of growth.—Length $1\frac{1}{4}$ inch; height (greatest) $\frac{52}{100}$ L; apical angle about 130°. Near *Mytilus Teploji* of Verneuil, (Russia, pl. xix, 17,) and *Modiolopsis faba*, of J. Hall, (N. Y. Palæont. Report, pl. xxxv, fig. 6.)—*Illawarra.*

43. *Modiolopsis prærupta.*—Elongate (length about twice the greatest height), enlarging somewhat posteriorly, dorsal margin straight or very slightly arcuate, rounding into the posterior margin; inferior excavate anterior to middle; front abruptly truncate; lateral surface excavate from the beak posteriorly downward, also an oblique depression adjoining anterior muscular impression; a few faint rays from the beak over the posterior surface, concentric striæ of growth distinct; anterior muscular impression marginal, excavate, but small and suborbicular. —Length $1\frac{4}{10}$ inch; greatest height $\frac{53}{100}$ L; apical angle 100°. Near *M. faba* of Hall.—*Illawarra.*

44. *Modiolopsis imbricata.*—Moderately elongate, enlarging posteriorly, very inequilateral; dorsal margin straight, and prolonged; inferior margin straight anteriorly, front rounded; lateral surface depressed or somewhat excavate from the beak obliquely backward and downward, having neat concentric subimbricate markings (and some fine radiations on the posterior surface of cast near beak); from beak to posterior margin scarcely carinate; anterior muscular impression very large, oblong, marginal; beaks of cast thin at summit. Texture of shell delicately fibrous and apparently no nacre below.*—Length $2\frac{1}{8}$ inches; greatest height about half the length.—*Harper's Hill.*

45. *Modiolopsis arcodes.*—A thick species resembling the preceding in form and in external markings; but it is much broader in proportion, lateral surface is less flattened anteriorly, cardinal line much shorter than shell, being much less prolonged posteriorly than in *M. imbricata*; line from beak posteriorly more decidedly carinate, beaks thicker. The fibrous texture is very distinct. The anterior muscular impression is very oblong vertically, and projects anterior to the beaks, nearly as in the *Myophora* of Bronn.—Length $1\frac{2}{3}$ inch; height much less than half length. Looks much like an Arca in general form.—*Harper's Hill.*

46. *Modiolopsis acutifrons.*—Thick, elongate, very much broader posteriorly; cardinal line straight, very oblique, very much shorter than shell; front acuminate, posterior broadly rounded; inferior margin excavate near anterior extremity and also just posterior to beak; lateral surface from beak downward and backward excavate, from beak to posterior margin very convex, hardly carinate; surface marked with a few concentric folds, and some lines of growth. Anterior muscular impres-

* Judging from this texture, the species of Modiolopsis (Hall) are more allied to Avicula than Mytilus, although having a large and strong anterior muscular impression.

sion large and deeply excavate, scarcely marginal. Texture of shell finely fibrous as in preceding species.—Length $3\frac{3}{4}$ inches; angle between cardinal line and line of elongation of shell about 32°. Resembles much a Gervillia in its oblique form.—*Illawarra.*

47. *Avicula* ——*?*—Very near *A. volgensis* of Verneuil, Russin, p. 473, pl. xli, fig. 13.—Specimen from *Illawarra.*

48. *Pecten comptus.*—Suborbicular, costæ 20 to 22, without markings, regular, prominent, low triangular with shallow concave furrows, which have usually at middle a slender costa and one or two similar less prominent either side; ears rather large and longitudinally striate. —Length and height $2\frac{1}{3}$ inches; distance at lower margin between middle of two costæ a fifth of an inch. Only one valve was obtained and that was convex. Near *P. Fittoni* of Morris, (Strzelecki, p. 277, pl. 14, fig. 2,) but rays much more numerous.—*Harper's Hill.*

49. *Pecten tenuicollis.*—Nearly orbicular; costæ about twenty-four, very slender and smooth with nearly flat smooth interstices having an intermediate smaller costa.—Length of specimen $1\frac{1}{8}$ inch; height $1\frac{1}{5}$ inch nearly; distance of middle of two costæ at lower margin about $\frac{1}{5}$ of a line. Only a single valve was obtained and that was very convex.—*Harper's Hill.*

50. *Pecten leniusculus.*—Large, nearly orbicular, one valve nearly flat, the other convex; flat valve having concentric undulations; surface very nearly smooth with fine obsolescent striations; striations more distant and rather more distinct on the convex valve; ears large, crossed obliquely by a few folds and striate longitudinally.—Length and height $4\frac{1}{2}$ inches; thickness $1\frac{1}{2}$ inch.—*Illawarra.*

The following additional species of fossil shells from Australia in our collections are described by Morris in *Strzelecki's N. S. Wales and Van Dieman's Land*, Mr. J. D. Sowerby in *Mitchell's Australia*, or G. Sowerby in Darwin *on Volcanic Islands.*

From *Harper's Hill*:—Bellerophon micromphalus (*M.*); Platyschisma oculus (*J. S.*) *M.*, P. rotundatum (*M.*); Theca lanceolata (*M.*); Spirifer subradiatus (*G. S.*); Eurydesma cordata (*M.*); Eurydesma (Isocardia? *J. D. S.*); Pecten illawarrensis (*M.*); Pachydomus antiquatus (*J. D. S.*) *M.*, P. cuneatus (*J. D. S.*) *M.*, Conularia levigata, (*M.*)

From Illawarra:—Pleurotomaria Strzeleckiana (*M.*); Spirifer Darwinii (*M.*); S. subradiatus (*G. S.*), S. avicula (*G. S.*), S. vespertilio (*G. S.*); Productus brachythærus (*G. S.*); Allorisma curvatum (M.); Orthonota (Cardinia) costata (*M.*); Pterinea macroptera (*M.*)

Our collections contain also other undetermined species from these localities, besides several species from Glendon, the species of corals described by Lonsdale, and several new species of coal plants from Illawarra and Newcastle.